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NATIONAL DAM INSPECTION PROGRAM. BAGGALEY DAM. (NDI NUMBER PA-0--ETC(U)  
MAY 80 J P HANNAN, J E BARRICK

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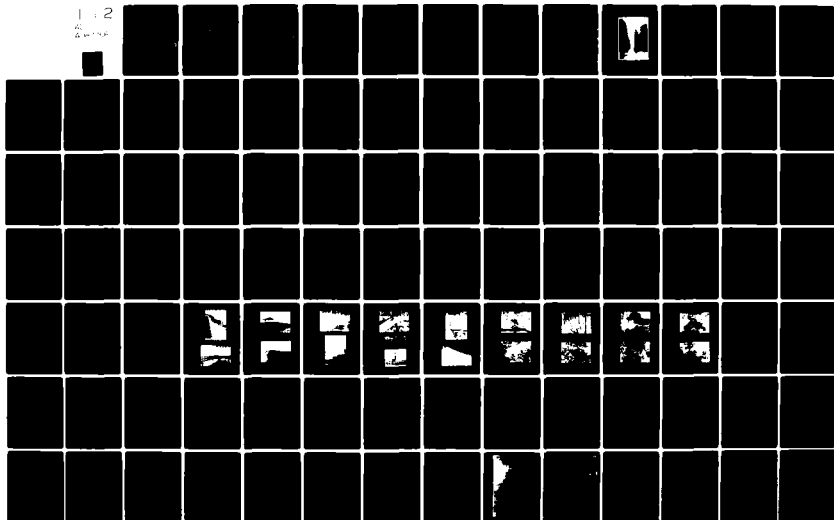
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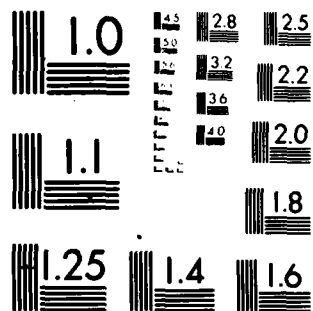
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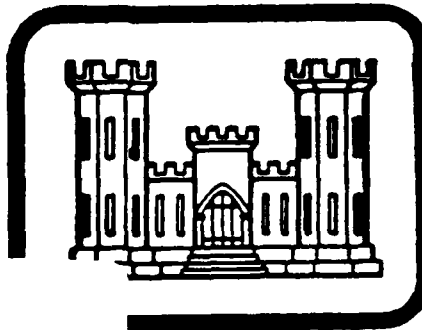
PENNSYLVANIA  
NDI No. PA 00454  
PENN DER No. 65-10

LEVEL IV

## BAGGALEY DAM

YOUNGSTOWN BOROUGH MUNICIPAL AUTHORITY

### PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM



ACKENHEIL & ASSOCIATES  
DACW31-80-C-0026 ✓

PREPARED FOR

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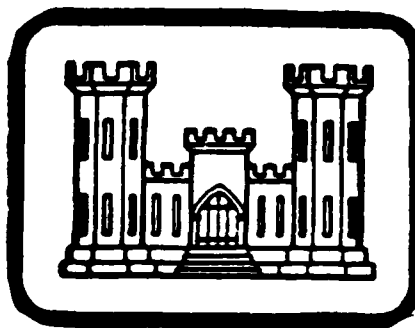
⑥ National Dam Inspection Program

Baggaley Dam  
(NDI Number PA-00454,  
Penn DER NO. 65-10)

OHIO RIVER BASIN, Indian Camp

~~BAGGALEY DAM~~  
WESTMORELAND COUNTY, ~~COMMONWEALTH OF~~ PENNSYLVANIA  
NDI NO. PA 00454  
PennDER NO. 65-10  
YOUNGSTOWN BOROUGH MUNICIPAL AUTHORITY.

PHASE 1 INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



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Prepared for: DEPARTMENT OF THE ARMY  
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15 DACW31-80-C-0026

Date: May 1980

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## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, materials testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some time in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" (PMF) for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS

NAME OF DAM: Baggaley  
STATE LOCATION: Pennsylvania  
COUNTY LOCATION: Westmoreland  
STREAM: Indian Camp Run, a tributary of  
Ninemile Run  
DATES OF INSPECTION: 28 November 1979, 3 April 1980  
COORDINATES: Lat. 40°15'22"  
Long. 79°21'56"

ASSESSMENT

Based on a review of available design information and visual observations of conditions as they existed on the date of the field inspections, the general condition of Baggaley Dam is considered to be poor. The poor assessment is based on the inability to closely observe the downstream slopes, potential stability problems of the abutments and the condition of the principal spillway.

The structure is classified as a "small" size, "high" hazard dam. Corps of Engineer guidelines recommend 1/2 to one times the Probable Maximum Flood for "small" size "high" hazard dams. Baggaley Dam's Spillway Design Flood is 1/2 the Probable Maximum Flood (PMF). Spillway capacity is "inadequate" because the non-overtopping flood discharge capacity, as estimated using the HEC-1 computer program, was found to be 10 percent of the PMF. The spillway is not "seriously inadequate" because failure of the structure would not significantly increase the flood stage and risk of loss of life downstream.

The visual inspection indicated deficiencies which are considered correctable. The deficiencies can be eliminated through implementation of the following recommended remedial, monitoring and/or maintenance efforts.

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SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)  
Baggaley Dam

RECOMMENDATIONS

a. Additional Investigations: Immediately retain a professional engineer knowledgeable in dam design and construction to:

(1) Perform a detailed hydrologic/hydraulic analysis of the reservoir and spillway and make recommendations on increasing the capacity of the system to make it adequate.

(2) Perform a detailed investigation of seepage and ground water conditions and structural stability of the embankment, abutments and spillway chute.

(3) Evaluate the condition of the two outlet works pipes and make recommendations on acceptable operation procedures and upstream flow control requirements.

b. Remedial Work: The Phase I investigation of Baggaley Dam also disclosed several deficiencies of lower priority which should be corrected during routine maintenance.

(1) Remove the trees, brush, and groundlitter from the embankment's downstream slope, groins, and toe area and from adjacent portions of the abutments. The removal of stumps from the embankment should be complete, and should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

(2) Repair cracks and deterioration in the spillway walls and slabs and remove debris from the approach channel.

(3) Clean the pond drain outlet pool and discharge channel to provide free, unobstructed drainage.



SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)  
Baggaley Dam

(4) Repair erosion damage on the embankment crest and upstream slope and raise the embankment crest to the elevation of the adjacent spillway training wall.

(5) Develop and implement formal maintenance and inspection procedures.

c. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(1) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

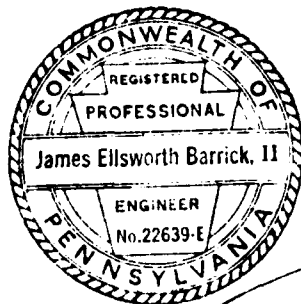
(2) Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

(3) Procedures for drawdown of the reservoir under emergency conditions.

(4) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

d. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure, to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer, in accordance with applicable state and local regulations.

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)  
Baggaley Dam



James P. Hannan 23 May 1980  
James P. Hannan Date  
Project Engineer

James E. Barrick, P.E. 23 May 1980  
James E. Barrick, P.E. Date  
PA Registration No. 022639-E

Approved by:

James W. Peck  
JAMES W. PECK  
Colonel, Corps of Engineers  
District Engineer

31 JUNE 1980

Date

BAGGALEY DAM



OVERVIEW

## TABLE OF CONTENTS

	<u>Page</u>
PREFACE . . . . .	i
SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS . . . .	ii
OVERVIEW PHOTOGRAPH . . . . .	vi
SECTION 1 - PROJECT INFORMATION	
1.1 General . . . . .	1
1.2 Description of Project . . . . .	1
1.3 Pertinent Data . . . . .	3
SECTION 2 - ENGINEERING DATA	
2.1 Design . . . . .	6
2.2 Construction . . . . .	7
2.3 Operation . . . . .	8
2.4 Evaluation . . . . .	8
SECTION 3 - VISUAL INSPECTION	
3.1 Findings . . . . .	9
3.2 Evaluation . . . . .	14
SECTION 4 - OPERATIONAL FEATURES	
4.1 Procedure . . . . .	17
4.2 Maintenance of Dam . . . . .	17
4.3 Inspection of Dam . . . . .	17
4.4 Warning System . . . . .	17
4.5 Evaluation . . . . .	17
SECTION 5 - HYDROLOGY AND HYDRAULICS	
5.1 Evaluation of Features . . . . .	18
SECTION 6 - STRUCTURAL STABILITY	
6.1 Available Information . . . . .	20
6.2 Evaluation . . . . .	20

## TABLE OF CONTENTS (cont'd)

	<u>Page</u>
SECTION 7 - ASSESSMENT AND RECOMMENDATIONS	
7.1 Assessment . . . . .	23
7.2 Recommendations. . . . .	24
APPENDIX A - VISUAL INSPECTION CHECKLIST	
Visual Observations Checklist I . . . .	A1
Field Plan . . . . .	A12
Field Profile and Section. . . . .	A13
APPENDIX B - ENGINEERING DATA CHECKLIST . . . . .	B1
APPENDIX C - PHOTOGRAPHS	
Photo Key Map . . . . .	C1
Photos 1 through 18 . . . . .	C2
Detailed Photo Descriptions . . . . .	C11
APPENDIX D - HYDROLOGY AND HYDRAULICS ANALYSES	
Methodology . . . . .	D1
Engineering Data . . . . .	D4
HEC-1 Data Base . . . . .	D5
Loss Rate and Base Flow Parameters . . .	D6
Elevation-Area-Capacity Relationship .	D6
Principle Spillway Plan . . . . .	D7
Overtop Parameters . . . . .	D7
Program Schedule . . . . .	D7
HEC-1 Computer Analysis . . . . .	D8
Damage Station Map . . . . .	D16
Reservoir/Spillway Hydrologic Performance Plot . . . . .	D17
APPENDIX E - PLATES	
List of Plates . . . . .	E1
Plates I through IV . . . . .	E2
APPENDIX F - GEOLOGY	
Geomorphology . . . . .	F1
Structure . . . . .	F1
Stratigraphy . . . . .	F1
Geologic Map . . . . .	F3
Geologic Column . . . . .	F4

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM  
BAGGALEY DAM  
NATIONAL I. D. NO. PA 00454  
PennDER NO. 65-10

SECTION 1  
PROJECT INFORMATION

1.1 GENERAL

a. Authority: The Phase I investigation was performed pursuant to authority granted by Public Law 92-367 (National Dam Inspection Act) to the Secretary of the Army through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose: The purpose of the investigation is to determine whether or not the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances:

(1) Embankment: Baggaley Dam was constructed as an earthfill embankment with a concrete core wall. The embankment is 180 feet long, with a toe to crest height of 34 feet and a crest width of 17 feet. The upstream slope is 2H:1V and the downstream embankment slopes are 1.3H:1V near the crest and 2H:1V near the toe.

(2) Spillway: The principal (and emergency) spillway for Baggaley Dam is an open channel on the left abutment, that is contained by concrete and masonry training walls. The spillway base is a concrete slab. Flow control and reservoir pool maintenance are by uncontrolled, broad crested weir at the entrance to the spillway. Low to moderate flows are discharged to the valley below via a concrete spillway chute. Higher flows will overtop a training wall and also discharge over a free overfall onto the abutment slope beside the concrete chute.

(3) Outlet Works: The dam has two outlet pipes that are controlled upstream by a concrete gatehouse. A 20 inch diameter cast iron pipe pond drain discharges to a pool at the toe of the embankment. A 10 inch diameter cast iron water supply pipe formerly provided water and pressure head for the water supply system of the Borough of Youngstown. Both pipes have gate valves immediately downstream of the dam.

b. Location: Baggaley Dam is located in Unity Township, Westmoreland County, Pennsylvania approximately 1 mile southeast of Baggaley and 1.5 miles south of Youngstown. The dam is situated on Indian Camp Run, a northwest flowing tributary of Ninemile Run, a tributary of Loyalhanna Creek, which joins the Conemaugh River at Saltsburg to form the Kiskiminetas River.

c. Size Classification: The dam has a maximum storage capacity of 38 acre-feet and a toe to crest height of 34 feet. Based on this criteria, the dam is classified as a "small" size structure.

d. Hazard Classification: Baggaley dam is classified as a "high" hazard dam. In the event of a dam failure, at least eight inhabited dwellings and some commercial development on the flood plain below the dam would be subjected to possible damage and loss of life could result.

e. Ownership: Baggaley Dam is owned by the Youngstown Borough Municipal Authority. Correspondence related to the dam should be addressed to:

Youngstown Borough Municipal Authority  
P. O. Box 82  
Youngstown, PA 15969  
(412) 539-8854  
Attn: Mr. Paul Kurtz, Chairman

f. Purpose of Dam: Baggaley Dam was constructed to supply water to the Borough of Youngstown. However, it is no longer used for that purpose and its current use is unknown.

g. Design and Construction History: Baggaley Dam was designed by J. H. Harlow and Company, Pittsburgh, Pennsylvania and constructed in 1898 for the Puritan Water Company, to furnish water for Unity Township, Westmoreland County. The H. C. Frick Coke Company subsequently leased the Puritan Water Company, using the water for domestic and industrial purposes at its Baggaley Works.

In 1904, there was a partial failure of Baggaley Dam due to inadequate spillway capacity. The embankment was overtopped, and portions of the crest and downstream embankment slope were washed away. A portion of the "wasteway" channel was damaged. Repairs were made by the H. C. Frick Coke Company and the embankment crest width was increased from 10 to 18 feet and the width of the wasteway was increased from 48 feet to 64 feet.

In October 1950, a permit was issued to the Puritan Water Company to drain and clean the reservoir and install a new outlet system. This new outlet system was designed by Richard J. Harman, Consulting Engineer, Harrisburg, Pennsylvania.

### 1.3 PERTINENT DATA

- a. Drainage Area: 1250 acres, 1.95 sq. miles
- b. Discharge at Dam Facility:

Maximum Known Flood at Dam	Overtopped in 1904* (discharge unknown)
Principal Spillway Capacity at Design Elevation	747 cfs
Principal Spillway Capacity at Current Top of Dam	407 cfs
- c. Elevation: (Feet above MSL)\*\*
 

Constructed Top of Dam	1258.0*
Design Highwater	1258.0*
Current Top of Dam (Low Point)	1257.1
Normal Pool	1255.3
Maximum Tailwater	Unknown
Principal Spillway Weir Crest	1255.3
Upstream Inlet of Outlet Pipe	1231.5* <sub>±</sub>
Lowest Point at Downstream Toe of Embankment	1223 <sub>±</sub>
- d. Reservoir Length:

Length of Maximum Pool	550 feet
Length of Normal Pool	500 feet
- e. Total Storage:

Current Top of Dam	26 acre-feet
Principal Spillway Weir Crest	20 acre-feet*
Normal Pool Level	20 acre-feet*



f. Reservoir Surface:

Constructed Top of Dam	4.0 acres
Design Highwater	4.0 acres
Spillway Crest	3.48 acres*
Normal Pool	3.48 acres*

g. Embankment:

Type	Earth*
Length	180 feet*
Height	34 feet
Top Width	17 feet
Slopes:	
Downstream	1.3H:1V to 2H:1V
Upstream	2H:1V*
Cutoff	Concrete core wall*

h. Outlet Works (Pond Drain):

Type	20 inch (nominal) diameter cast iron pipe
Inlet	Gatehouse
Conduit Length	135 feet*
Gate Valve	Yes, downstream
Upstream Flow Control	Yes
Anti-Seep Collars	None shown*

i. Outlet Works (Water Supply Pipeline):

Type	10 inch (nominal)* diameter cast iron pipe
Inlet	Gate house
Conduit Length	155 feet*
Gate Valve	Two shown on Plate III, one observed in field, both downstream
Upstream Flow Control	Yes*
Anti-Seep Collars	None shown*

j. Regulating (and Emergency) Outlet

Type	Open channel
Flow Control	Broad crested weir
Length	64 feet
Weir Crest Elevation	1255.3

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\* Taken or derived from available information in PennDER or owner's records.

\*\*To obtain elevations shown on Plate III and Plate IV, add twenty-two feet.

## SECTION 2 ENGINEERING DATA

### 2.1 DESIGN

a. Data Available: The following information and data may be obtained from the Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania. This information was reviewed for this study.

(1) "Report Upon the Baggaley Dam of the Puritan Water Company" dated Harrisburg, 6 January 1915.

(2) One design drawing by James H. Harlow and Company, Engineers showing a plan view of the embankment, a cross-section of the embankment, cross-section of the embankment excavation and elevations of the core wall.

(3) Seepage monitoring weir measurements from May 1915 to July 1921.

(4) Eleven inspection reports by Water and Power Resource Board employees from 13 June 1919 to 14 April 1964.

The following information was obtained from the Youngstown Borough Municipal Authority:

(5) Two drawings by Richard J. Harmon, Consulting Engineer, Harrisburg, Pennsylvania dated 3 March 1950 and 14 April 1950 showing the dam and construction details of the proposed "gatehouse and walkway . . ." and miscellaneous details related to the water supply system.

b. Design Features:

(1) Embankment: The embankment was designed by James H. Harlow and Company, Engineers, Pittsburgh, Pennsylvania in 1898, as an earthfill structure with concrete core wall and masonry spillway on the left abutment. The core wall approached to within two feet of the crest and was keyed a variable depth (8 feet to 16 feet as scaled) into the foundation. The embankment was designed to be 34 feet high, with a 10 foot wide

crest. The downstream face had two slopes separated by an eight foot wide bench at about mid-height. The upper slope was 3H:2V and the lower slope was 2H:1V. The upstream slope was uniform at 2H:1V. The upstream portion of the embankment was to be "Selected Fill, Rammed" and the downstream portion was to be a "Waste Bank".

(2) Principal (and Emergency) Spillway: The original spillway was an open channel on the left abutment having a masonry wall along the embankment side and a paved base. The control section was a one foot high weir and freeboard was designed (but apparently not constructed) to be 8 feet. Discharge from the downstream end of the spillway was to the natural slope of the left abutment.

(3) Outlet Works: Two pipes were placed through the embankment. On the right was a 20 inch diameter cast iron pond drain with gate valve at the downstream end. On the left was a 10 inch diameter cast iron water supply pipe also with downstream gate valve. The gate valves were located inside control houses at the toe of the embankment. Both pipes were supported on stone piers beneath the upstream portion of the embankment.

## 2.2 CONSTRUCTION

a. Constructor: The dam was constructed for the Puritan Water Company in 1898 under the direction of J. H. Harlow.

b. Modifications: In 1904, the dam was overtopped with resultant damage to the downstream slope of the embankment. Repairs were made immediately that included widening the crest to 18 feet, flattening the upper portion of the downstream slope by backfilling the bench and making improvements to the principal spillway to increase its discharge capacity. In 1950, the reservoir was drawn down and a new "gatehouse" intake structure erected.

Sometime before 1964, the principal spillway was reconstructed to the present configuration with the addition of the concrete spillway chute and diversion training wall.

### 2.3 OPERATION

According to the Pennsylvania Department of Environmental Resources, the Youngstown Borough Municipal Authority is responsible for operation of Baggaley Dam.

The principal (and emergency) spillway is uncontrolled and performance and operation records are not maintained.

The pond drain gate valve is normally closed. In 1959, use of the facility for water supply was terminated and the water supply line gate valve was closed according to a representative of the Municipal Authority. The dam and appurtenances do not normally require a dam tender.

### 2.4 EVALUATION

a. Availability: Available design information and drawings were obtained from the Pennsylvania Department of Environmental Resources and the Youngstown Borough Municipal Authority.

b. Adequacy: The available design information and drawings are reasonably documented, and are considered adequate to evaluate the dam and appurtenances in accordance with the scope of a Phase I study. Based on a review of this data, the dam and appurtenant structures are considered to have been designed in general conformance with accepted engineering practices of the day.

c. Validity: Based on the available data, there is no reason to question the validity of the obtained design information and drawings.

### SECTION 3 VISUAL INSPECTION

#### 3.1 FINDINGS

a. General: The visual inspections of Baggaley Dam and reservoir were performed on 28 November 1979 and 3 April 1980 and consisted of:

- (1) Visual observations of the embankment crest and slopes, groins, and abutments;
- (2) Visual observations of the spillway including concrete and masonry training walls, concrete slab and chute.
- (3) Visual observations of the exposed sections of the water supply pipeline and pond drain.
- (4) Visual observations of downstream conditions and evaluation of the downstream hazard potential.
- (5) Visual observations of the reservoir shoreline and inlet stream channel.
- (6) Transit stadia survey of relative elevations along the embankment crest centerline, spillway, and across the embankment slopes.
- (7) A geological reconnaissance of the site.

A second site visit was performed on 3 April 1980 to:

- (8) Review site conditions and obtain photographs for report preparation and presentation.

The visual observations were made during periods when the reservoir and tailwater were at normal operating levels.

The field plan, sections, and visual observations checklist containing the observations and comments of the field inspection team are contained in Appendix A. Specific observations are illustrated on photographs in Appendix C. Detailed findings of the visual inspection are presented in the following sections.

b. Embankment:

(1) Crest and Upstream Slope: The embankment crest was straight and fully vegetated with grass and weeds and the stadia survey showed a sag of 0.8 feet near the center. Minor erosion of the crest was observed left of the embankment's center where a path crosses the downstream slope.

The upstream slope was grass and weed covered. A bench just below the water line suggested that minor erosion has occurred.

(2) Downstream Slope: The downstream slope was densely covered with small trees, brush and considerable duntimber. Much of the duntimber was the result of tree cutting at sometime in the past and many of the live trees were growing from stumps. The downstream slope was reasonably uniform and no signs of high ground water were visible. However, close inspection was impossible due to ground cover conditions.

The stadia survey indicated the downstream slope to be steeper near the crest than near the toe. The upper portion of the slope was measured to be 1.3H:1V while the lower portions was measured to be 1.9H:1V.

Based on surficial observations, the downstream portion of the embankment appeared to be constructed of sand and gravel type materials.

A collapsed, rotted wooden staircase was observed on the right side of the slope.

(3) Groins (Junction of Embankment and Abutment): The right groin was tree and brush covered making close inspection difficult. However, there were no significant indications of erosion. No seepage was observed along the upper groin but water was seeping from a boulder strewn area near the lower end of the collapsed staircase. The area between the boulders and the rightmost abandoned foundation was marshy but no significant flows were observed.

A seepage zone was observed in and near the left groin, on the right side of the spillway chute. Several springs were discharging from a boulder strewn area, with the uppermost spring, being approximately twelve feet below the embankment crest. Total seepage flow from the area

was estimated to be 15 gallons per minute and was flowing down the groin to a confluence with the pond drain outlet channel.

c. Abutments:

(1) Right: The right abutment was heavily wooded and brush covered and contained a drainage swale that was carrying flow from a spring. The elevation of the spring was near or slightly above the embankment crest. The swale discharged to the pool below the pond drain outlet. A bench in the abutment between the embankment and the drainage swale was observed to be halfway between the toe and crest of the embankment. Origin of the bench could not be determined although it did not appear to be a recent development.

(2) Left: The left abutment appeared to be a fill material upon which the concrete spillway chute was constructed. It was heavily wooded and brush covered, and contained a portion of the seepage zone described above.

Beyond the spillway, the upper left abutment is quite flat and contains the access road to the dam. In the vicinity of the original spillway overflow crest, the abutment has been badly eroded by flowing water. A high, steep soil face was visible in the area to the left of the spillway chute. With the exception of the soil face, the left abutment area was heavily wooded and brush covered.

d. Outlet Works:

(1) Intake Structure: The intake structure for the pond drain and water supply pipeline is a concrete riser type "gatehouse" located in the reservoir and connected to the embankment crest by a concrete and steel walkway. The gatehouse top contained three hand-wheel controls with floor stands. All three handwheels were free to turn but were not activated.

The condition of the visible portion of the gatehouse was good and the concrete portion of the walkway was fair, with some concrete deterioration. The steel walkway was in good condition as was the pipe handrail.

(2) Pond Drain: The pond drain is 20 inch (nominal) diameter cast iron pipe that discharges directly to the pool just below the toe of dam. A valve stem was observed in a riser just upstream of the pipe outlet.



(3) Water Supply Pipeline: The only evidence of the reported ten inch diameter cast iron water supply pipeline was a transite pipe riser at the toe of the dam. The location of the riser corresponded with the expected location of a water supply pipe gate valve.

f. Instrumentation: No formal instrumentation was observed during the inspection.

g. Principal (and Emergency) Spillway:

(1) Approach Channel: The approach channel of the principal spillway consists of a formed and jointed concrete slab lying between concrete or masonry training walls. The width of the approach channel has been modified by construction of a concrete training wall across the channel, that converges and directs flow to a concrete spillway chute. The training wall prevents lower spillway flows from passing over the original spillway overflow crest on the left abutment.

The concrete slab was observed to have badly spalled and deteriorated construction joints and holes through the slab were noted. A minor amount of debris, consisting of brush and timber and a manhole cover was noted on both inspection dates. Large flow capacity of the spillway was not compromised by the debris.

The training walls were both concrete and masonry. On the right side, the concrete walls were in good condition except for a large vertical crack a few feet upstream of the spillway chute. Water was flowing through the crack and disappearing into the rock and gravel foundation materials. A section of masonry training wall on the right side was intact but contained numerous open joints.

The top elevation of the right training wall was observed to fall from a high point on the concrete section at the upstream end of the approach channel.

The left training wall (newer diversion wall) was in good condition, but was observed to fall in elevation from the reservoir to the concrete spillway chute. The left training wall (original channel) was masonry with numerous open joints and some rock displacement.

(2) Overflow Crests: The overflow crest to the newer concrete spillway chute was unobstructed.

Flow over the crest was of uniform depth indicating a level condition. The overflow section of the bypassed original spillway consisted of a masonry wall which was collapsing and seepage was observed. Brush and small trees were growing through the training wall and slab. The alignment of debris in the channel and on the abutment indicated the passage of spillway flows since construction of the diversion training wall.

(3) Discharge Channel: The discharge channel consisted of the concrete chute on the right and the original channel on the left.

The chute concrete was intact except for a raised construction joint partway down the chute that was causing a minor disruption in chute flow. The chute discharges to the original rock lined stream channel below. Some erosion has occurred, such that flows drop a few additional feet across rock debris after leaving the chute.

The original discharge channel, immediately to the left of the chute, lies in an erosional area on the left abutment. The channel was heavily debris littered with dountimber, brush and boulders.

h. Downstream Conditions:

(1) Toe Area: The toe area of the embankment contains a shallow, marshy pool just below the pond drain outlet. The pool discharges to a channel that flows to the left into the stream channel below the spillway chute.

A large spring and some diffuse seepage was observed along the pool perimeter in the immediate vicinity of the pond drain outlet.

Two abandoned masonry foundations lie at the toe of the embankment. The right foundation was about two feet deep and dry. The left foundation was three to four feet deep and had standing water about two feet below the surrounding ground surface.

(2) Downstream Channel: The downstream channel below the dam is a typical mountain brook. It is wide and generally unobstructed immediately below the spillway chute discharge point, but is winding and littered with trees, dountimber and boulders below. The valley is heavily wooded and uninhabited for a distance of 2400 feet below the dam.

(3) Flood Plain Development: At least eight inhabited dwellings lie on the flood plain in the one mile reach between the dam and the confluence with Ninemile Run in Baggaley.

i. Reservoir:

(1) Slopes: The reservoir left slope is flat to moderately steep and heavily wooded. The right slope is steep and heavily wooded. No recent instability was observed, but some runoff related erosion of steep slopes was noted.

(2) Inlet Stream: The inlet stream is a typical mountain brook. It is winding, steep and obstructed by boulders, trees, down timber and debris. The inlet area of the reservoir appeared to have some sediment deposits but the extent of sedimentation could not be determined.

(3) Watershed: The watershed lies on the west slope of Chestnut Ridge and is mostly wooded except for a large quarry operation beginning about 3000 feet above the dam. No upstream impoundments were observed on Indian Camp Run or tributaries above the dam, but observations were limited by access conditions.

3.2 EVALUATION

a. Embankment: The inability to perform satisfactory visual observations of the embankment is considered to be a deficiency. However, no major signs of instability or high ground water were observed in the embankment.

The crest and upstream slope are in good condition although some minor erosion was noted.

The large seepage zone in the left groin and on the left abutment is assessed to be a deficiency. The origin of the flow could not be determined but some evidence indicated that it might be coming from the deteriorated spillway.

The seepage observed from the boulders at the right toe of embankment is considered to be a deficiency. However, there was no indication of movement of soil fines and the flow was not large.

b. Abutments:

(1) Right: No major indication of reservoir related seepage was observed on the right abutment. The bench halfway up the slope may be a sign of slope instability, but there was no indication of recent movement or distress.

(2) Left: In addition to the seepage zone discussed above, erosion of the left abutment beyond the spillway chute is considered to present a potential problem. Long term weathering of bedrock and possible future high ground water could lead to collapse of the hillside and possible damage to or destruction of the spillway chute.

c. Outlet Works:

(1) Intake Structure: The structural condition of the gatehouse and steel walkway appeared to be good. The concrete portion of the walkway was assessed to be in fair condition.

An evaluation of the operational and hydraulic characteristics of the flow controls cannot be made because their performance was not observed during the inspection.

(2) Pond Drain: The condition of the pond drain cannot be assessed because it's operation was not observed. It is not known if the pipe's inlet is closed or open or whether the reported gate valve at the toe of the dam is controlling pipe flow. This condition is assessed to be a deficiency.

(3) Water Supply Pipeline: The lack of information on structural and operating conditions of the reported water supply pipeline is assessed to be a deficiency.

d. Principal Spillway:

(1) Structural Conditions: The principal spillway is assessed to be in poor condition and in need of considerable maintenance work. A particular concern is the leakage of water through deteriorated parts of the spillway into the left abutment and embankment area.

Also, the large crack in the right training wall may be an indication of downstream movement of the chute, possibly due to erosion of foundation support once provided by the downstream channel.

The condition of the original portion of the spillway is very poor. Collapse of the overflow wall and bank erosion of the abutment below, are of particular concern.

e. Downstream Conditions:

(1) Toe Area: The seepage observed along the perimeter of the pool below the embankment is considered to be a deficiency. However, no significant indication of movement of soil fines was observed. The pool outlet channel was in need of maintenance.

(2) Hazard Classification: Based on visual observations of downstream floodplain conditions, the hazard classification for Baggaley Dam is considered to be "high". This is based on the number and location of inhabited dwellings on the floodplain below the dam, and the potential for damage and a loss of life in the event of a dam failure.

## SECTION 4 OPERATIONAL FEATURES

### 4.1 PROCEDURE

Reservoir pool level is maintained by the uncontrolled weir crest of the principal spillway. Normal operating procedure does not require a dam tender.

The outlet works gatehouse has three inlet ports at various elevations in the reservoir. The inlets to both the pond drain and water supply pipelines are inside the gatehouse and are thus controlled by the inlet ports. Individual pipe controls do not appear to exist at the upstream end of either pipe. Consequently, the pond drain pipe would necessarily be under full pressure through the embankment if the water supply pipeline were operative, which would be the normal operating condition.

### 4.2 MAINTENANCE OF DAM

The embankment and appurtenances are maintained by the Youngstown Borough Municipal Authority.

### 4.3 INSPECTION OF DAM

The Youngstown Municipal Authority is required by the State of Pennsylvania to inspect the dam annually and make needed repairs.

### 4.4 WARNING SYSTEM

There is no known warning system or formal emergency procedure to alert or evacuate downstream residents upon threat of a dam failure.

### 4.5 EVALUATION

There are no written operation, maintenance or inspection procedures, nor is there a warning system or formal emergency procedure for this dam. These procedures should be developed in the form of checklists and step by step instructions, and should be implemented as necessary.

Current operating conditions are unknown, as the reservoir is not now used as a water supply source.

SECTION 5  
HYDROLOGY AND HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data. The Baggaley Dam reservoir has a watershed of 1,250 acres which is vegetated primarily by woodland and includes a 30 acre rock quarry operated by Eidemiller Enterprises.

The watershed is about 1.2 miles long and has a maximum width of about 1.1 miles. The maximum elevation of the watershed is 2170 feet above Mean Sea Level (MSL). At normal pool, the dam impounds a reservoir with a surface area of about 3.5 acres and a storage volume of 20 acre-feet. Normal pool level is maintained at Elev. 1255.3 by the principal spillway.

According to PennDER files, the design of the proposed spillway was adequate but no calculations exist indicating what the state requirement for structures of this size was at the time of design. The Baggaley Dam spillway capacity for the observed cross section and existing freeboard condition was computed to be 407 cfs. No additional hydrologic calculations were found relating reservoir/spillway performance to the Probable Maximum Flood or fractions thereof.

b. Experience Data: Continuous records of reservoir level or rainfall amounts are not kept.

Records indicate that the dam was overtopped in 1904 without suffering a disastrous failure.

c. Visual Observations: On the date of the field reconnaissance, the spillway was observed to be in fair to poor condition. However, no condition was observed that would compromise the spillway functionality on a short term basis.

d. Overtopping Potential: Overtopping potential was investigated through the development of the Probable Maximum Flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. The Corps of Engineers guidelines recommend 0.5 to 1 times the PMF for "small" size, "high" hazard dams. Based on the observed downstream conditions, Baggaley Dam has a Spillway Design Flood (SDF) of one half PMF.

Hydrometeorological Report No. 33 indicates that the adjusted 24 hour Probable Maximum Precipitation (PMP) for the subject site is 19.2 inches. No calculations are available to indicate whether the reservoir and spillway are sized to pass a flood corresponding to 9.6 inches of rainfall in 24 hours (1/2 PMP). Consequently, an evaluation of the reservoir/spillway system was performed to determine whether the dam's spillway capacity is adequate under current Corps of Engineers guidelines.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California. The major methodologies and key input data for this program are discussed briefly in Appendix D.

The peak inflow to Baggaley Dam for the SDF was determined by HEC-1 to be 2,125 cfs.

e. Spillway Adequacy: The capacity of the combined reservoir and spillway system was determined to be 0.10 PMF using HEC-1. An initial pool elevation of 1255.3 was assumed prior to commencement of the storm. According to Corps of Engineers' guidelines, Baggaley Dam's spillway is "inadequate."

At 0.50 PMF, the dam is overtopped by 1.70 feet of water for 9 hours and 45 minutes. This overtopping depth and duration condition could lead to failure of the structure in the judgement of the evaluating engineer. Consequently, a dam breach analysis was performed to determine if the spillway is "seriously inadequate."

For the dam breach analysis, it was assumed that dam failure would begin when the water level in the reservoir reached Elev. 1258.1 which corresponds to a depth of one foot above the crest's observed minimum elevation.

To achieve the assumed overtopping failure condition, a 0.28 PMF was routed through the reservoir/spillway system. Initially, the flood wave was routed downstream without embankment failure conditions considered. Results of the dam breach analysis indicated that downstream flooding and the risk of loss of life would not be significantly increased by the assumed failure of the dam. The stream level about one mile downstream would rise 0.5 feet with an increase in flow of 26 percent. Therefore the Baggaley Dam's spillway is rated "inadequate" but not "seriously inadequate."



## SECTION 6 STRUCTURAL STABILITY

### 6.1 AVAILABLE INFORMATION

a. Design and Construction Data: All available design documentation, calculations and other data received from the Pennsylvania Department of Environmental Resources were reviewed. This data is discussed in Section 2 and a detailed listing is included in Appendix B. Selected items are presented in Appendix E.

b. Operating Records: There are no written operating records or procedures for this dam.

### 6.2 EVALUATION

a. Design Documents: The design documentation was, by itself, considered inadequate to evaluate the structure. There were no structural calculations associated with the stability of the embankment or of the appurtenant structures.

b. Visual Observations:

(1) Embankment: The field inspection, though hindered by trees, brush and groundlitter, disclosed no strong evidence of potential instability of the embankment. No major indication of foundation and/or embankment movement was observed and there were no visible indications of high ground water in the embankment. The embankment slopes were measured to be moderately steep by current standards.

(2) Abutments: The right abutment between the embankment and the drainage swale contained a pronounced bench formation suggestive of a slope failure. However, there was no indication of recent movement or of a more general stability problem on the right abutment.

The immediate left abutment, between the embankment and spillway, was observed to have a significant flow of ground water at a high elevation. The origin of the ground water and the extent to which it exists within the abutment could not be determined. Although there

were no signs of slope instability in the area, and considerable gravel and rock were observed on the ground surface. The high ground water condition represents a potential for slope instability.

The far left abutment, beyond the spillway chute was observed to be steep and barren, having been eroded in the past by original spillway flows. Additional erosion of the slope's toe and/or the entrance of ground water from the relatively flat upper abutment area, may lead to slope instability that could threaten the structural integrity of the principal spillway chute.

(3) Seepage: The springs observed in the pond drain outlet pool area have been observed for many years and do not appear to represent a serious problem. In the left abandoned foundation, the water surface is two feet below the ground surface, indicating a generally favorable ground water condition.

(4) Principal Spillway: The structural condition of the principal spillway was adequate at the time of inspection. However, the existence of a large crack in the training wall near the chute and the observed, continued erosion of the area below the toe of the chute raises questions about the long term stability of the structure.

c. Performance: In 1904, the dam was overtopped and the downstream slope partially eroded, but disastrous failure of the embankment did not occur. This was attributed to the stabilizing effect of the concrete core wall.

In 1948, significant erosion of the left abutment occurred as a result of ground water flows. The erosion reportedly damaged the principal spillway. No record could be found indicating the source of the ground water or the remedial measures taken to correct the problem.

d. Seismic Stability: According to the Seismic Risk Map of the United States, Baggaley Dam is located in Zone 1 where damage due to earthquakes would most likely be minor.

A dam located in Seismic Zone 1 may be assumed to present no hazard from an earthquake provided static stability conditions are satisfactory and conventional safety margins exist. Since there is concern regarding the static stability of the embankment, the seismic stability is questionable and should be assessed as part of the investigations recommended in Section 7.

SECTION 7  
ASSESSMENT AND RECOMMENDATIONS

7.1 ASSESSMENT

a. Evaluation:

(1) Embankment: The inability to closely observe Baggaley Dam's embankment's slope is considered to be a deficiency. However, no strong indications of slope instability were observed.

(2) Abutments: The abutments of Baggaley Dam were observed to have slope or ground water conditions suggestive of potential stability problems.

(3) Outlet Works: The condition of the two pipelines through the embankment could not be determined. The handwheels at the gatehouse appeared to be operable, but it could not be determined if the inlet ports were open or closed. Consequently, it could not be determined if the pipelines are under full pressure through the embankment. This is considered to be a deficiency.

(4) Principal Spillway: The condition of the principal spillway is considered to be poor. This is based on:

i. The "inadequate" capacity rating determined using the HEC-1 computer program. The spillway was found to pass only 10 percent of the PMF. The Spillway Design Flood is 0.5 PMF because of the dam size and hazard classification.

ii. The physical condition of spillway components, particularly the base slab and masonry walls.

iii. The potential for detrimental movement of the spillway chute as a result of either foundation or left abutment failure.

(5) Downstream Toe Area: Seepage near the pond drain outlet is considered to represent a potential problem. However, the seepage zones have been known for many years and have given no indication of possible piping problems.

(6) Hazard Classification and Spillway Design  
Flood: Visual observations of flood plain conditions below Baggaley Dam indicate that the structure has "high" hazard classification and requires an SDF of 0.5 PMF.

b. Adequacy of Information: The information available on design, construction, operation and performance history in combination with visual observations and hydrology and hydraulic calculations were sufficient to evaluate the embankment and appurtenant structures in accordance with the Phase I investigation guidelines.

c. Urgency: The recommendations presented in Section 7.2a and 7.2c should be implemented immediately.

d. Necessity for Additional Data/Evaluation: Additional engineering information is required to adequately evaluate the stability of the facilities.

## 7.2 RECOMMENDATIONS

a. Additional Investigations: Immediately, retain a professional engineer knowledgeable in dam design and construction to:

(1) Perform a detailed hydrologic/hydraulic analysis of the reservoir and spillway and make recommendations on increasing the capacity of the system to make it adequate.

(2) Perform a detailed investigation of seepage and ground water conditions and structural stability of the embankment, abutments and spillway chute.

(3) Evaluate the condition of the two outlet works pipes and make recommendations on acceptable operation procedures and upstream flow control requirements.

b. Remedial Work: The Phase I investigation of Baggaley Dam also disclosed several deficiencies of lower priority which should be corrected during routine maintenance.

(1) Remove the trees, brush, and groundlitter from the embankment's downstream slope, groins, and toe area and from adjacent portions of the abutments. The removal of stumps from the embankment should be complete, and should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

(2) Repair cracks and deterioration in the spillway walls and slabs and remove debris from the approach channel.

(3) Clean the pond drain outlet pool and discharge channel to provide free, unobstructed drainage.

(4) Repair erosion damage on the embankment crest and upstream slope and raise the embankment crest to the elevation of the adjacent spillway training wall.

(5) Develop and implement formal maintenance and inspection procedures.

c. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(1) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

(2) Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

(3) Procedures for drawdown of the reservoir under emergency conditions.

(4) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

d. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer in accordance with applicable state and local regulations.

APPENDIX A  
VISUAL INSPECTION CHECKLIST

VISUAL OBSERVATIONS CHECKLIST I  
(NON-MASONRY IMPOUNDING STRUCTURE)

Name Dam Baggaley County Westmoreland State Pennsylvania National ID # PA00454  
Type of Dam Earthfill Hazard Category High

Date(s) Inspection 28 November 1979 and 3 April 1980

Weather Cold, cloudy on 28 November 1979

Temperature 40°F on 28 November 1979

Pool Elevation at Time of Inspection +1255

Tailwater at Time of Inspection +1227 (MSL)

Inspection Personnel: J. E. Barrick\*, P.E. Ackenheil & Associates, Hydrologist and Project Manager.  
J. P. Hannan Ackenheil & Associates, Geotechnical Engineer  
S. G. Mazzella\* Ackenheil & Associates, Civil Engineer  
J. B. Zeppieri Ackenheil & Associates, Geologist  
Mr. Chester Myers Youngstown Borough Municipal Authority

Recorder J. E. Barrick

GEO Project G79153-0  
PennDER I.D. No. 65-10

\*Returned to site on 3 April 1980 to obtain photographs for report preparation and presentation.



# EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Minor erosion of the upstream slope evidenced by presence of a bench immediately below waterline. Crest width not significantly affected. Path on downstream slope, left of center, has been eroded to the extent that the downstream edge of the crest has been locally affected.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Alignment is straight and crest appears to be level.	
RIPRAP FAILURES	No riprap observed.	

# EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SETTLEMENT	None observed.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Rock rubble fill is evident for a considerable distance along the left groin area. The right groin is concealed by heavy ground cover, brush and dountimber. Both groins are heavily wooded.	
ANY NOTICEABLE SEEPAGE	<p>A drainage swale exists on the right abutment beyond the embankment toe. The flow appears to emanate at a spring 50 feet downstream of embankment crest centerline, at an elevation above reservoir water level. A small seep is flowing from beneath rock rubble at downstream embankment toe just to the right of the right most abandoned foundation. Three feet to left of the outlet pipe is a seep which may be originating from rock rubble at downstream toe.</p> <p>Seeping water evident for considerable distance along left embankment slope in groin. Highest elevation of seeping water is 12 feet below embankment crest, here several seeps are emitting flows totaling 10 gpm. Another seep present flowing 5 gpm from rock rubble just to left of previously described seeps.</p> <p>Significant seep six feet below crest of spillway and five feet from left wingwall. Here water is seeping from rock rubble at 5 gpm.</p> <p>Immediately adjacent to left wingwall at the spillway chute toe is an erosional scar. A 25 gpm flow emanates from rock rubble at this point.</p>	

EMBANKMENT

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
ANY NOTICEABLE SEEPAGE CONT'D	Standing water and marshy condition exist beyond the toe of the dam near pond drain outlet. Inflow to the area includes drainage swale off right abutment and seepage from dam toe area.	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

OUTLET WORKS  
(POND DRAIN)

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Pond drain is 20 inch (nominal) diameter cast iron pipe.	
INTAKE STRUCTURE	Intake inside of gatehouse tower. Handwheels with floor stands on top of tower. Operability not checked but handwheels are free to turn.	
OUTLET STRUCTURE	Open pipe end discharges to pool. No flow controls visible but valve box observed in bottom of collapsed foundation ten feet above end of pipe.	
OUTLET CHANNEL	Open channel with rock and timber debris, looks like natural channel. Poor appearance, but functional.	
EMERGENCY GATE	None observed.	

**OUTLET WORKS  
(WATER SUPPLY PIPE)**

<b>VISUAL EXAMINATION OF</b>	<b>OBSERVATIONS</b>	<b>REMARKS OR RECOMMENDATIONS</b>
<b>CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT</b>	Conduit not observed.	
<b>INTAKE STRUCTURE</b>	Intake inside of gatehouse tower. Handwheels with floor stands on top of tower. Operability not checked but handwheels are free to turn.	
<b>OUTLET STRUCTURE</b>	None observed.	
<b>OUTLET CHANNEL</b>	None.	
<b>EMERGENCY GATE</b>	None observed.	

# INSTRUMENTATION

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
<u>MONUMENTATION/SURVEYS</u>	None observed.	
<u>OBSERVATION WELLS</u>	None observed.	
<u>WEIRS</u>	Overflow crest of spillway chute. Not calibrated for flow measurement. No other weirs observed.	
<u>PIEZOMETERS</u>	None observed.	
<u>OTHER</u>		

PRINCIPAL (UNGATED) SPILLWAY

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
GENERAL DESCRIPTION	<p>Open channel on left abutment with old stone and mortar and newer concrete training walls. Base is concrete slab. Initial opening (broad crested weir) to 64 feet. Concrete training wall reduces channel width to 16 feet and directs flow into a concrete chute spillway. Older portion of spillway now blocked by training wall. Original discharge was directly to abutment hillside. Result was considerable erosion of hillside.</p>	
CONCRETE CONDITION	<p>Slab - Poor condition. Considerable spalling and deterioration around slab joints. Slab eroded through at one location.</p> <p>Training Walls - Fair to good condition. Large crack in training wall near approach to chute. Water leaking through.</p> <p>Chute - Good condition. One construction joint near downstream end has raised with resulting minor disruption of flow.</p>	
STONE AND MORTAR CONDITION	<p>Training Walls - Right side wall fair condition with numerous open joints. Left side wall fair to poor condition with open joints and some rock displacement.</p> <p>Overflow Wall - Very poor condition, in state of collapse.</p> <p>Spillway Foundation Wall - Fair to poor condition. In state of collapse at point below concrete wall crack near chute. Otherwise, numerous open joints.</p>	

PRINCIPAL (UNGATED) SPILLWAY CONT'D

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
APPROACH CHANNEL	Small amount of debris on slab, otherwise clear and unobstructed.	
DISCHARGE CHANNEL (CHUTE)	Unobstructed except for raised construction joint noted above. Outfall is into rock channel. Chute slope measured to be 1.5H:1V.	
BRIDGE AND PIERS	None observed.	

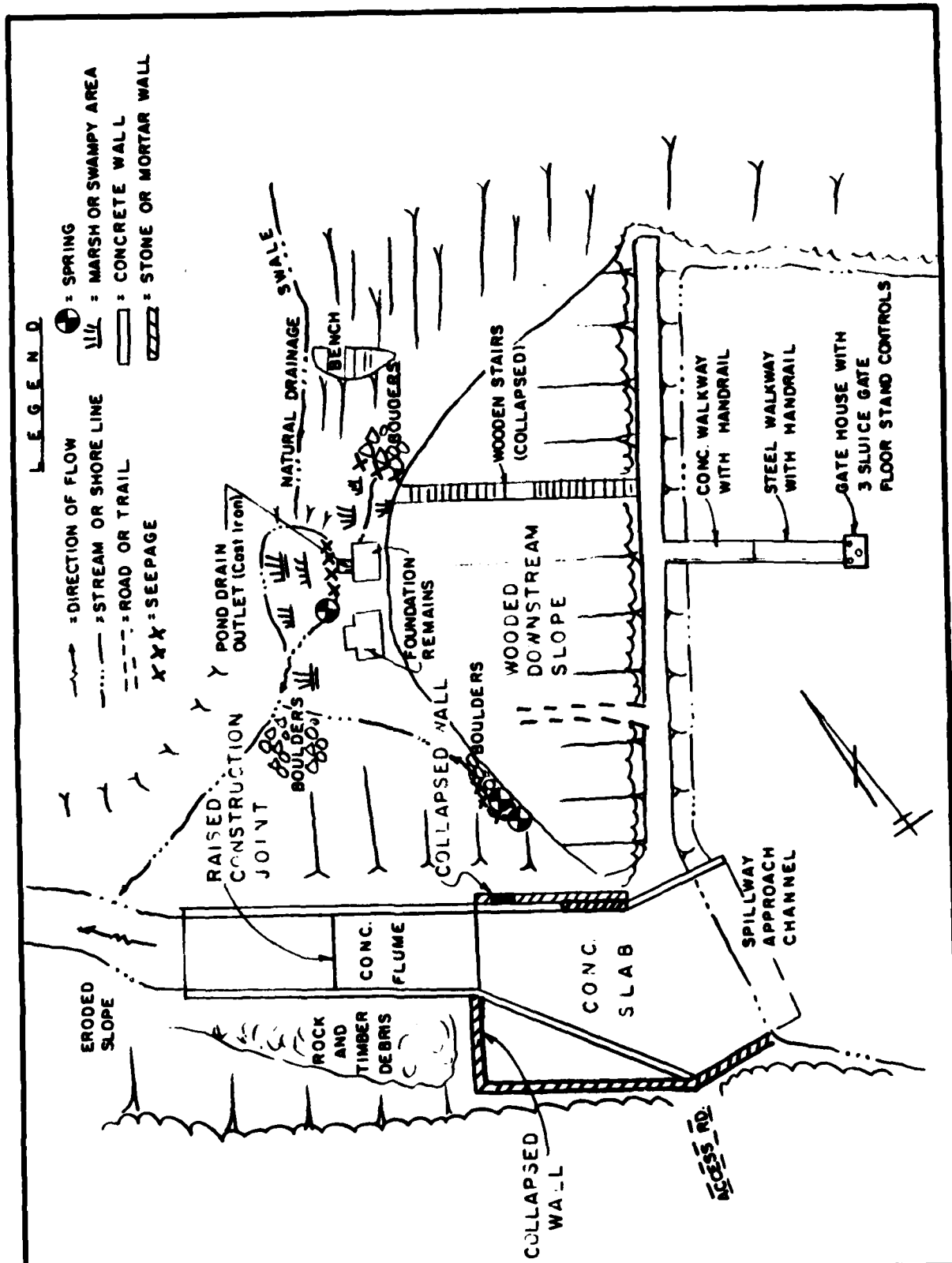


DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel below end of spillway chute - natural mountain brook channel - rock, timber, debris. Winding and steep. Tree and brush lined.	
SLOPES	Moderately steep to flat. Dense vegetation - trees and brush.	
APPROXIMATE NO. OF HOMES AND POPULATION	Several homes lie on the flood plain beginning about 2,400 feet downstream of the dam. U.S.G.S. shows eight homes immediately adjacent to channel above confluence with Ninemile Run, one mile below dam. At least that many observed.	

# RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Left slope is moderately steep and wooded. Right slope is relatively flat and wooded. No recent instability observed. Some dountimber and brush at the shoreline. Also, some general erosion of steeper slopes due to surface runoff.	
SEDIMENTATION	Some sedimentation observed at inlet to reservoir.	
WATERSHED	Watershed lies on the west slope of Chestnut Ridge and is mostly wooded. A large limestone quarry exists in and adjacent to the Indian Camp Run creek valley beginning about 3,000 feet above the dam. No impoundments were observed above the dam.	



DATE: MAY 1980

SCALE: NONE

DR: PT CK: JEB

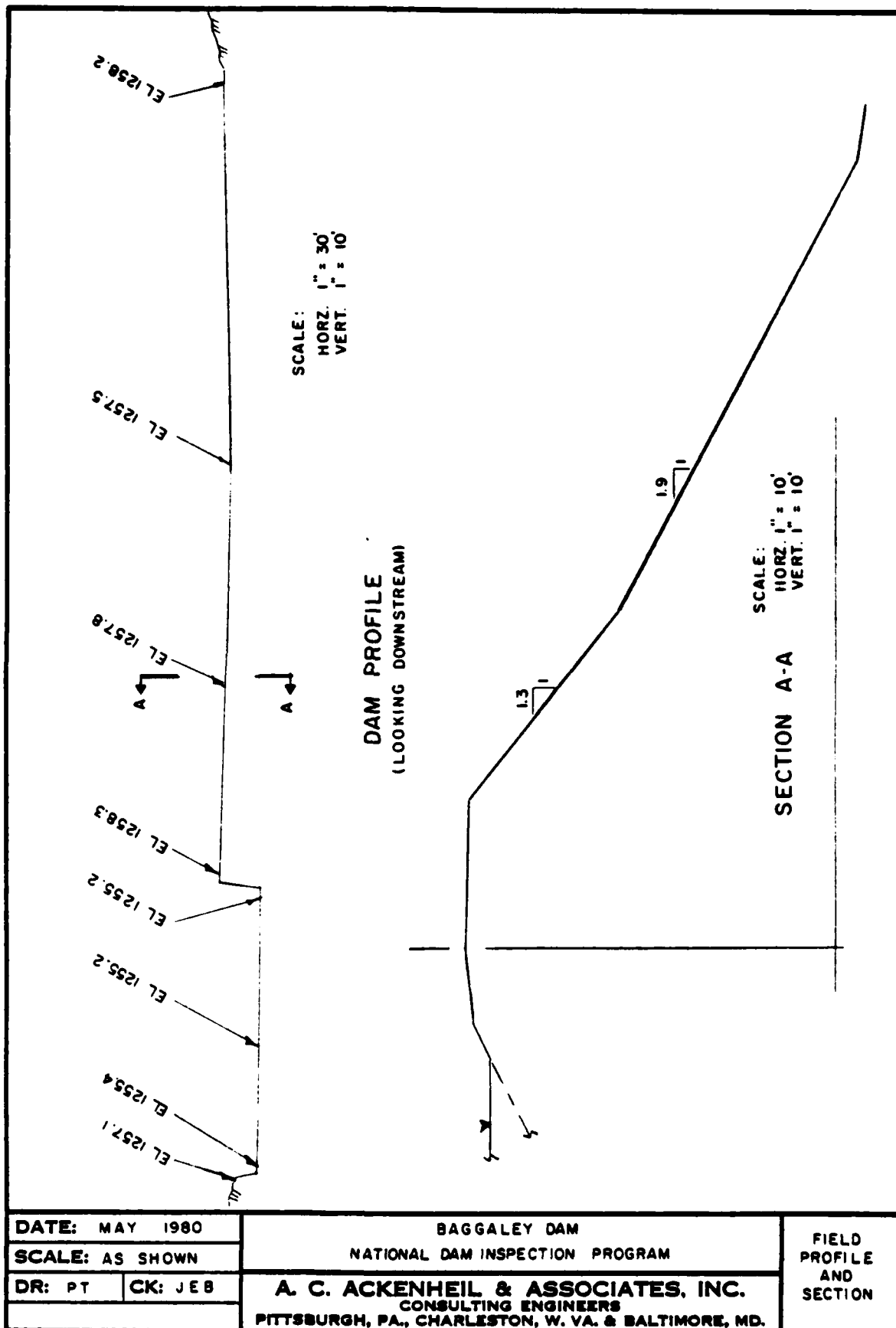
# BAGGLEY DAM

NATIONAL DAM INSPECTION PROGRAM

**A. C. ACKENHEIL & ASSOCIATES, INC.**  
CONSULTING ENGINEERS

PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.

FIELD  
PLAN



APPENDIX B  
ENGINEERING DATA CHECKLIST

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE I

NAME OF DAM: Baggailey Dam  
I.D. NO. PA 00454

ITEM	REMARKS
*Design Drawings	Design drawing by James H. Harlow and Company, Engineers, including:  "Puritan Water Company, Wolf Spring Reservoir Dam" showing a plan view of embankment, a cross-section of embankment, cross-sections of the excavation and elevation of the core wall dated 20 October 1898.
**Design Drawings	Design drawings by Richard J. Harman, Consulting Engineer, including:  "Borough of Youngstown, Youngstown, Pennsylvania. Gate House and Walkway, Details of Stream, Railway Crossings and Fire Hydrant"; also showing a cross-section of the embankment, dated 14 April 1950.  "Borough of Youngstown, Youngstown, Pennsylvania. Map showing Property of Puritan Water Company Reservoir, Source of Supply and Distribution System", dated 3 March 1950.
As-Built Drawings	None available.

ITEM	REMARKS
Regional Vicinity Map	See Appendix E.
*Construction History	Constructed in 1898 for the Puritan Water Company under direction of J. Hayward Harlow.
*Typical Sections of Dam	See Design Drawings above.
*Outlets-Plan Details Constraints Discharge Ratings	See Design Drawings above.
Rainfall/Reservoir Records	None available.
*Design Reports	See "Report Upon the Baggailey Dam of the Puritan Water Company", 6 January 1915.
Geology Reports	None available.
Design Computations Hydrology and Hydraulics Dam Stability Seepage Studies	None available.
Materials Investigations Boring Records Laboratory Field	None available.
Post-Construction Surveys of Dams	None reported.

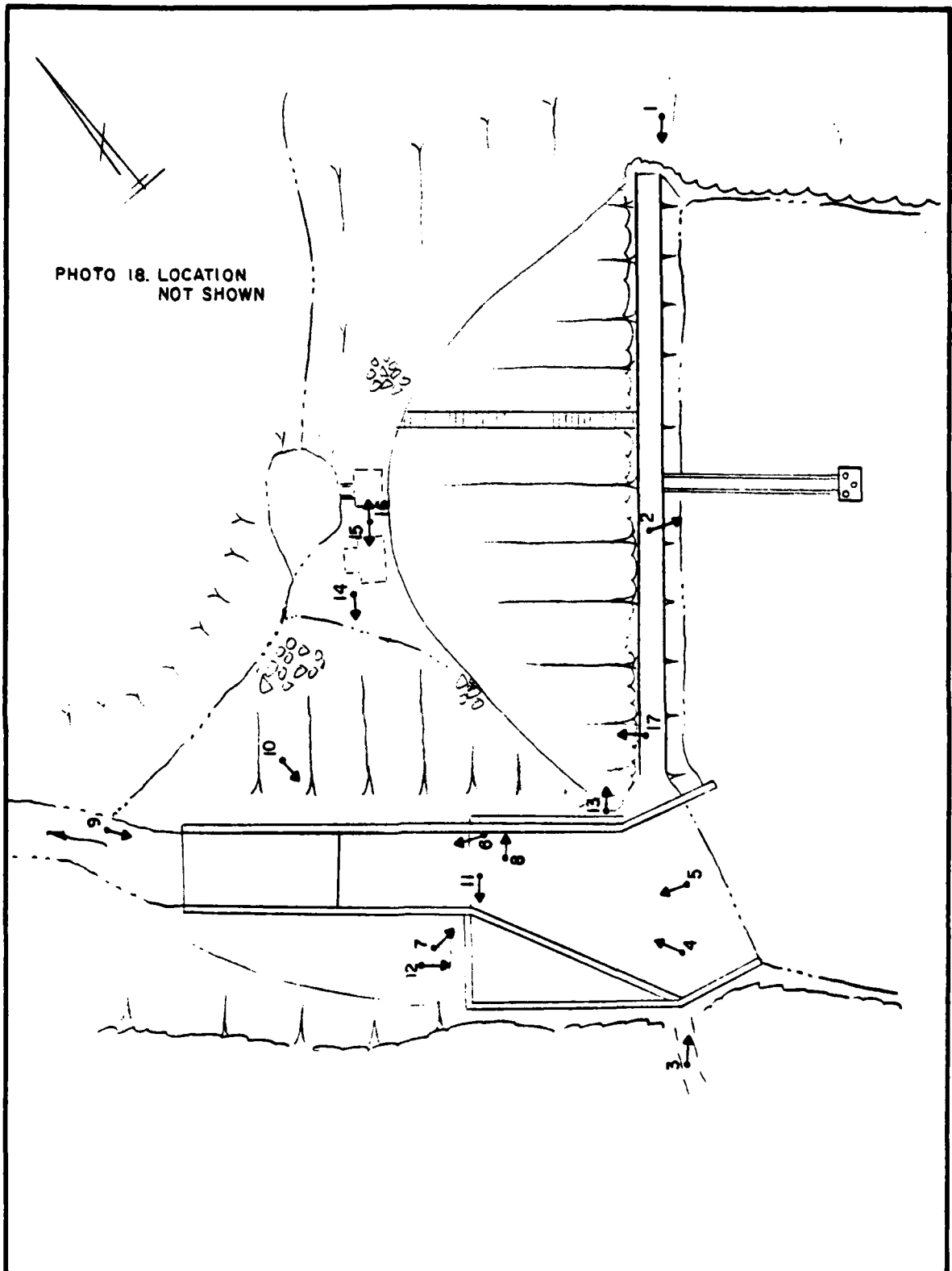
ITEM	REMARKS
Borrow Sources	Data not available.
Monitoring Systems	Weekly weir readings for period May 1915 to July 1921.
Modifications	Embankment top width increased from 10 to 18 feet and an 8 foot wide berm at elevation 1242 on downstream slope was eliminated. In 1950, the outlet works were modified in conjunction with a new water supply system being constructed. See Design Drawings above.
High Pool Records	None available.
Post-Construction Engineering Studies and Reports	See Design Drawings and Design Reports above.
Maintenance, Operation, Records	None available.
Spillway-Plan Sections Details	See Design Drawings above.
Operating Equipment Plans and Details	See Design Drawings above.
Specifications	None available.
Miscellaneous	None.



ITEM	REMARKS
*Prior Accidents or Failure of Dam Description Reports	In 1904, there was a partial failure of Baggailey Dam due to inadequate spillway capacity. The embankment was overtopped and portions of the crest and downstream slope were washed away and a portion of the wasteway was damaged. The structure did not fail disastrously because of the concrete corewall.
* Information and data may be obtained from the Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.	
**Information and data obtained from Youngstown Borough Municipal Authority. Reduced size reproduction in Appendix E.	

APPENDIX C  
PHOTOGRAPHS

PHOTO 18. LOCATION  
NOT SHOWN



DATE: MAY 1980		BAGGALEY DAM		PHOTO KEY MAP
SCALE: NONE		NATIONAL DAM INSPECTION PROGRAM		
DR: PT	CK: JEP	A. C. ACKENHEIL & ASSOCIATES, INC.		
		CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.		

BAGGALEY DAM



PHOTO 1. EMBANKMENT CREST



PHOTO 2. WALKWAY AND GATE HOUSE

BAGGALEY DAM

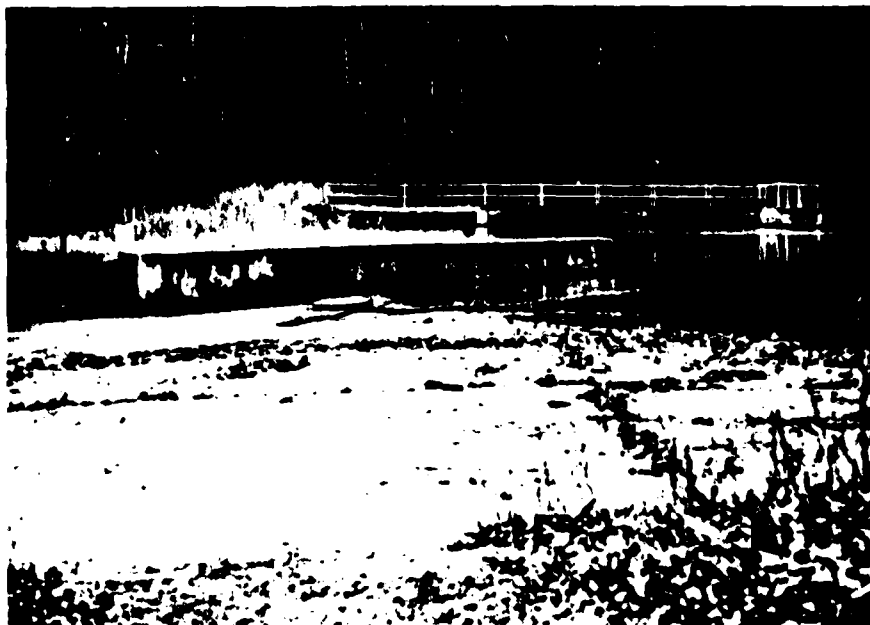


PHOTO 3 SPILLWAY APPROACH CHANNEL

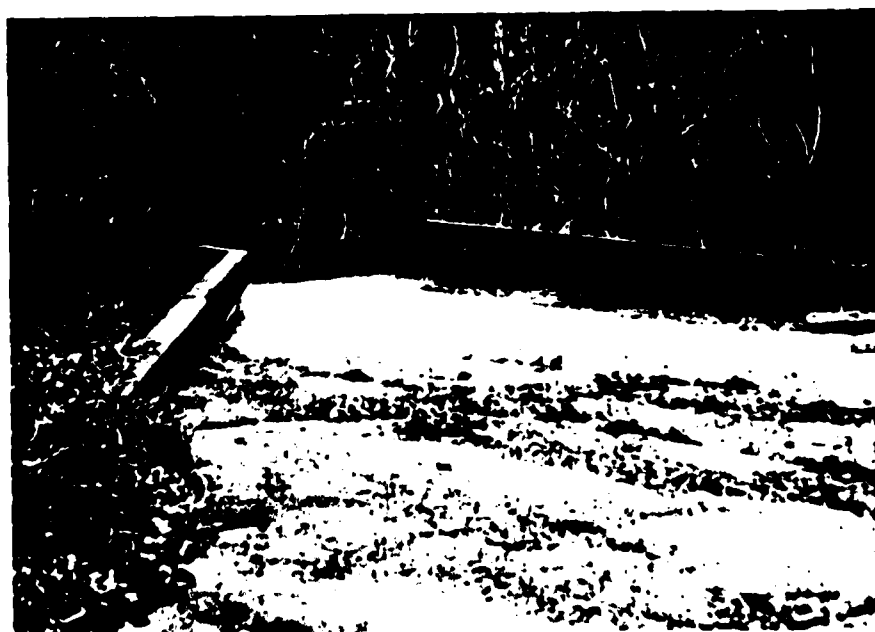


PHOTO 4. SPILLWAY CHUTE APPROACH

BAGGALEY DAM



PHOTO 5 SPILLWAY APPROACH CHANNEL



PHOTO 6. SPILLWAY CHUTE AND  
DOWNSTREAM CHANNEL

# BAGGALEY DAM

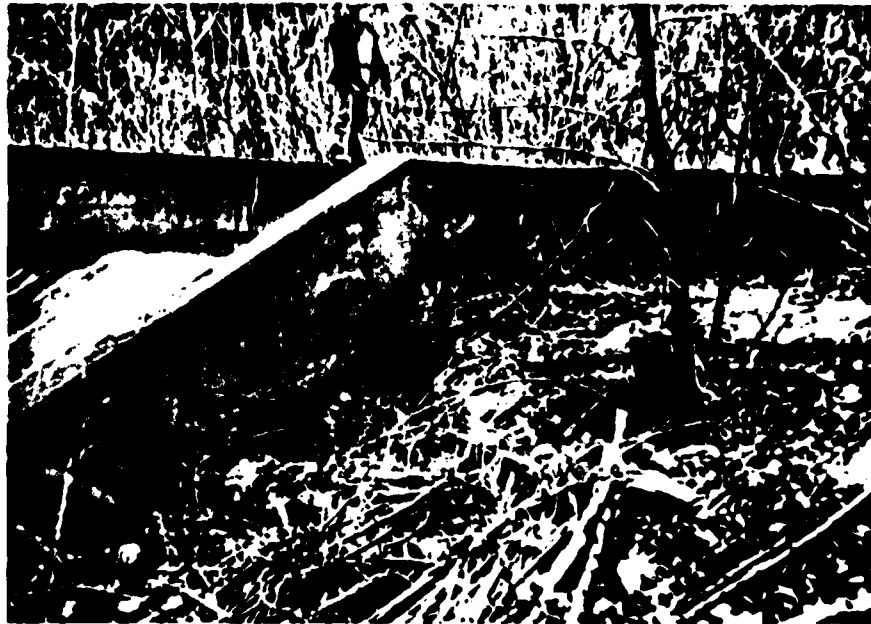


PHOTO 7. SPILLWAY CHUTE AND OLD OVERFLOW CREST



PHOTO 8. CRACK IN SPILLWAY TRAINING WALL

BAGGALEY DAM



PHOTO 9. SPILLWAY CHUTE

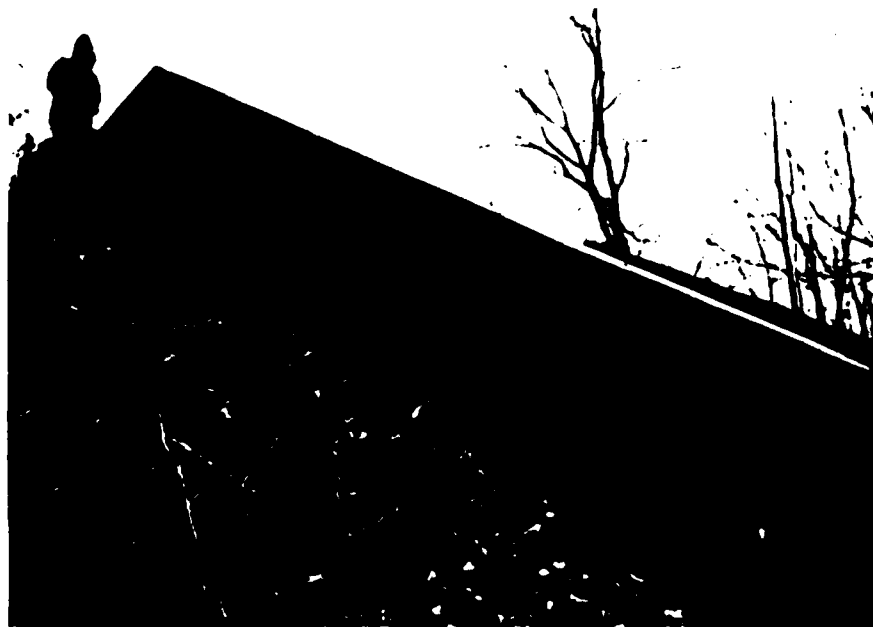


PHOTO 10. SPILLWAY CHUTE WALL



BAGGALEY DAM



PHOTO 11. ORIGINAL SPILLWAY CREST



PHOTO 12. SEEPAGE BELOW ORIGINAL SPILLWAY CREST

BAGGALEY DAM



PHOTO 13. DOWNSTREAM SLOPE



PHOTO 14. FLOWING WATER AT EMBANKMENT TOE

BAGGALEY DAM



PHOTO 15. ABANDONED FOUNDATION



PHOTO 16. ABANDONED FOUNDATION

BAGGALEY DAM



PHOTO 17 DOWNSTREAM CHANNEL



PHOTO 18 DOWNSTREAM DEVELOPMENT

### DETAILED PHOTO DESCRIPTIONS

- Photo 1 - Embankment Crest from right abutment. Spillway approach channel is at top of photo.
- Photo 2 - Walkway and Gate House and reservoir right shoreline.
- Photo 3 - Spillway Approach Channel as seen from the left abutment. Old stone training wall visible at left of photo.
- Photo 4 - Spillway Chute Approach showing concrete training walls and slab.
- Photo 5 - Spillway Approach Channel looking toward left abutment. Note the concrete training wall that now diverts flow into spillway chute.
- Photo 6 - Spillway Chute and Downstream Channel. Note the slope erosion on the left, caused by the original spillway that is now bypassed by the training wall shown in Photo 5 above.
- Photo 7 - Spillway Chute and Old Overflow Crest. The old crest is now bypassed.
- Photo 8 - Crack in Spillway Training Wall, embankment side. Crack is also visible in Photo 7 above.
- Photo 9 - Spillway Chute as seen from below. Raised construction joint and flow disturbance visible halfway up chute.
- Photo 10 - Spillway Chute Wall, embankment side. Note leakage at wall and floor construction joint.
- Photo 11 - Original Spillway Crest and approach channel now bypassed by concrete training wall.
- Photo 12 - Seepage Below Spillway Crest.
- Photo 13 - Downstream Slope as seen from the left groin, showing dense tree cover.

DETAILED PHOTO DESCRIPTIONS CONT'D

- Photo 14- Flowing Water at Embankment Toe. Sources of water are springs located in the left groin of the embankment.
- Photo 15 - Abandoned Foundation (left) at embankment toe. Water surface is two feet below ground surface.
- Photo 16 - Abandoned Foundation (right). Note absence of water. Left and right foundations are ten feet apart.
- Photo 17 - Downstream Channel as seen from spillway chute crest. Note flow channel from embankment toe area.
- Photo 18 - Downstream Development with Indian Camp Run visible behind dwelling.

APPENDIX D  
HYDROLOGY AND HYDRAULICS ANALYSES

## APPENDIX D HYDROLOGY AND HYDRAULICS

Methodology: The dam overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation: The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph: The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters, their definition and how they were obtained for these analyses.

<u>Parameter</u>	<u>Definition</u>	<u>Where Obtained</u>
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel	From U.S.G.S. 7.5 minute topographic map
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic map



Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic map

3. Spillway Hydraulics: Principal (and emergency) spillway flow control is assumed to be by broad crested weir at the entrance to the spillway channel. Normal and critical depth for maximum flow conditions at the spillway inlet and at the entrance to the concrete chute show that flows beyond the inlet (broad crested weir) will be super-critical.

Therefore, the capacity of the discharge channel above the concrete chute is in excess of the capacity of the broad crested weir inlet and the latter should control flow from the reservoir.

4. Routing: Reservoir routing is accomplished by using Modified Puls routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation-discharge relationship.

Storage in the pool area is defined by an area-elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

5. Dam Overtopping: Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

\*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

6. Dam Breach Downstream Routing: The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGIC AND HYDRAULIC  
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominately woodland.

Rock quarry in upper watershed.

ELEVATION TOP NORMAL POOL (STORAGE  
CAPACITY): 1255.3 (20 acre-feet.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE  
CAPACITY): 1257.1 (26 acre-feet.)

ELEVATION MAXIMUM DESIGN POOL: Design 1258.0

ELEVATION TOP DAM: Design 1258.0, observed minimum 1257.1

OVERFLOW SECTION

- a. Elevation 1255.3
- b. Type Concrete spillway
- c. Width 64 feet
- d. Length N/A
- e. Location Spillover Left abutment
- f. Number and Type of Gates None

OUTLET WORKS

- a. Type 10 inch outlet pipe
- b. Location Through dam near centerline
- c. Entrance Inverts + 1231.5
- d. Exit Inverts Unknown
- e. Emergency Drawdown Facilities 20 inch CI pond drain

HYDROMETEOROLOGICAL GAGES

- a. Type None
- b. Location N/A
- c. Records None

MAXIMUM REPORTED NON-DAMAGING

DISCHARGE Overtopped in 1904, no discharge capacity recorded

HEC-1 DAM SAFETY VERSION  
HYDROLOGY AND HYDRAULIC ANALYSIS  
DATA BASE

NAME OF DAM:	Baggaley Dam	NDI ID NO.	
		PA	454
Probable Maximum Precipitation (PMP)		24*	
Drainage Area		1.95 sq. mi.	
Reduction of PMP Rainfall for Data Fit		0.8 (24)	
Reduce by 20%, therefore PMP rainfall =		=19.2 in.	
Adjustments of PMF for Drainage Area (Zone 7)			
6 hrs.		102%	
12 hrs.		120%	
24 hrs.		130%	
Snyder Unit Hydrograph Parameters			
Zone		24**	
C <sub>p</sub>		0.45	
C <sub>t</sub>		1.6	
L		1.70 mile	
L <sub>ca</sub>		0.76 mile	
t <sub>p</sub> = C <sub>t</sub> (L · L <sub>ca</sub> ) <sup>0.3</sup> =		1.73 hours	
Loss Rates			
Initial Loss		1.0 inch	
Constant Loss Rate		0.05 inch/hour	
Base Flow Generation Parameters			
Flow at Start of Storm	1.5 cfs/sq.mi=	2.93 cfs	
Base Flow Cutoff		0.05 x Q peak	
Recession Ratio		2.0	
Overflow Section Data			
Crest Length		64 feet	
Freeboard		1.8 feet	
Discharge Coefficient		2.63	
Exponent		1.5	
Discharge Capacity		407 cfs	

\* Hydrometeorological Report 33

\*\* Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C<sub>p</sub> and C<sub>t</sub>).

**ACKENHEIL & ASSOCIATES**

GEO Systems, Inc.  
1000 Banksville Road  
PITTSBURGH, PA. 15216  
(412) 531-7111

Sheet \_\_\_\_\_ of \_\_\_\_\_

Job Faggaley Dam Job No. 791530

Subject Data Input

Made By JDH Date 4/21/80 Checked SHB Date 7/24/80

LOSS RATE AND BASE FLOW PARAMETERS

As Recommended By Corps of Engineers, Baltimore District

STRCL = 1 inch  
CNSTL = 0.05 "/hour  
STRTO = 1.5 cfs/mi.<sup>2</sup>  
QRCSN = 0.05 ( 5 % of Peak Flow)  
RTIOR = 2.0

Elevation - Area - Capacity - Relationships

From USGS 7.5min Quad, Penn DEE Files, Owners Files  
AND Field Inspection Data

At elevation 1256.0

Storage = 22.3 Acre Feet

Pond Surface Area = 3.48 Acres

At elevation 1280 Area = 13.8 acres

From Conic Method of Reservoir Volume  
Flood Hydrograph Package (Hec-1)  
Dam Safety Version (Users Manual)

$$H = 3V/A = 3(22.3)/3.48 = 19.2 \text{ feet}$$

Elevation where Area Equals Zero

$$1256.0 - 19.2 = 1236.8$$

AREA	SA	0.0	3.48	13.8
ELEVATION	SE	1236.8	1256.0	1280

# ACKENHEIL & ASSOCIATES

GEO Systems, Inc.  
1000 Banksville Road  
PITTSBURGH, PA. 15216  
(412) 531-7111

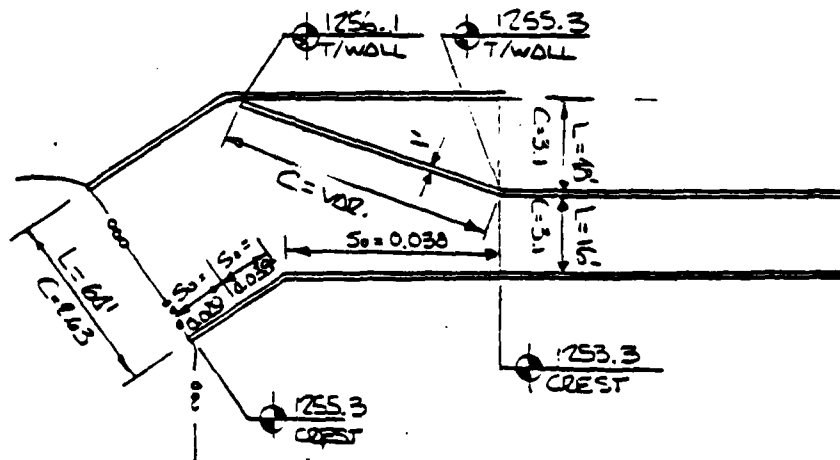
Sheet \_\_\_\_\_ of \_\_\_\_\_

Job BAGGALEY Dam Job No. 791530

Subject DATA INPUT

Made By JDH Date 4/29/80 Checked EWS Date 4/29/80

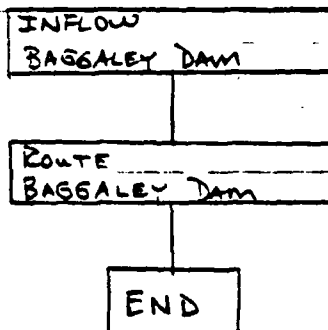
## PRINCIPAL (EMERGENCY) SILLWAY



## OVERTOP PARAMETERS

TOP OF DAM ELEVATION (LOW POINT)	1257.1
LENGTH OF DAM (EXCLUDING SPILLWAY)	186 FEET
COEFFICIENT OF DISCHARGE	3.08
$S_{Lmax} = 400$ $S_{Vmax} = 1260$	

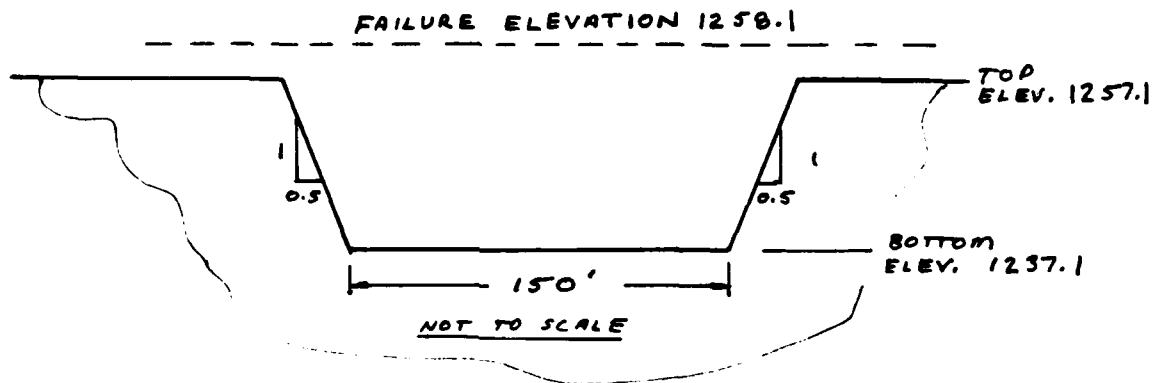
## PROGRAM SCHEDULE



ACKENHEIL & ASSOCIATES  
GEO Systems, Inc.  
1000 Banksville Road  
PITTSBURGH, PA. 15216  
(412) 531-7111

Sheet \_\_\_\_\_ of \_\_\_\_\_  
Job BAGGLEY DAM Job No. 79153-0  
Subject BREACH & DOWNSTREAM RATING PARAMETERS  
Made By JPH Date 1/29/80 Checked SEM Date 1-29-80

## BREACH PARAMETERS



RATIO OF PMF (RTIO) = 0.28  
SIDE SLOPE OF BREACH (Z) = 0.50  
FAILURE TIME (TFAIL) = 2 HOURS

## CHANNEL ROUTING

CHANNEL ROUTING CROSS-SECTIONS OBTAINED FROM U.S.G.S. 7 1/2 MIN. QUAD.

CHANNEL - MANNING'S "n"  $Q_N(2) = 0.03$   
OVERBANK - MANNING'S "n"  $Q_N(1) = 0.07$

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

1	A1	NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS									
2	A2	HYDROLOGIC AND HYDRAULIC ANALYSIS OF BAGGALEY DAM									
3	A3	PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD									
4	B	300	0	5	0	0	0	0	0	0	0
5	B1	5									
6	J	1	5	1							
7	J1	1.	0.8	0.5	.3	.2					
8	K	0	1					1			
9	K1	INFLOW HYDROGRAPH FOR BAGGALEY DAM									
10	M	1	1	1.95		1.95					
11	P		24	102	120	130					
12	T							1.0	.05		
13	W	1.73	0.45								
14	X	-1.5	-0.05	2.0							
15	K	1	2					1			
16	K1	ROUTING AT BAGGALEY DAM									
17	Y				1	1					
18	Y1	1						22.3			
19	\$A	0.0	3.48	13.8							
20	\$E1236.8		1256.0	1280.0							
21	\$S1255.3		64.	2.63	1.5						
22	\$D1257.1		3.08	1.5	186.						
23	\$L	20.	160.	140.	206.	400.					
24	\$V1257.1		1257.5	1258.	1258.5	1260.					
25	K	99									
26	A										
27	A										
28	A										
29	A										
30	A										

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

RUN DATE: 28 APR 80  
 RUN TIME: 8.21.38

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS  
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF BAGGALEY DAM  
 PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION									
NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	1	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIC= 5 LRTIC= 1  
 RTICS= 1.00 0.80 0.50 0.30 0.20

\*\*\*\*\*



## SUB-AREA RUNOFF COMPUTATION

## INFLOW HYDROGRAPH FOR BAGGALEY DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE LAUTC  
1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA  
IHVDC IUNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL  
1 1 1.95 0.0 1.95 0.0 0.0 0 1 0

PRECIP DATA  
SPFE PMS R6 R12 R24 R48 R72 R96  
0.0 24.00 102.00 120.00 130.00 0.0 0.0 0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA  
LROPT STRKR DLTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP  
0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA  
TP= 1.73 CP=0.45 NTA= 0

RECESSION DATA  
STRTO= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 1.74 HOURS, CP= 0.45 VOL= 0.93

3.	12.	25.	41.	60.	79.	101.	123.	147.	172.
197.	222.	245.	266.	285.	301.	314.	325.	334.	339.
340.	336.	327.	317.	307.	298.	289.	280.	272.	264.
256.	248.	240.	233.	226.	219.	213.	206.	200.	194.
188.	183.	177.	172.	166.	161.	157.	152.	147.	143.
139.	134.	130.	126.	123.	119.	115.	112.	108.	105.
102.	99.	96.	93.	90.	87.	85.	82.	80.	77.
75.	73.	71.	68.	66.	64.	62.	61.	59.	57.
55.	54.	52.	50.	49.	47.	46.	45.	43.	42.
41.	39.	38.	37.	36.	35.	34.	33.	32.	31.

0  
MO.DA HR.MN PERIOD RAIN EXCS LOSS END-OF-PERIOD FLOW  
COMP Q MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

SUM 24.96 23.08 1.88 320619.  
( 634.)( 586.)( 48.)( 9078.93

\*\*\*\*\*

## HYDROGRAPH ROUTING

## ROUTING AT BAGGALEY DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE LAUTC  
2 1 0 0 0 0 1 0 0

ROUTING DATA  
QLOSS CLOSS AVG IRES ISAME IOPT IPMP LSTP  
0.0 0.0 0.0 1 1 0 0 0

NSTPS NSTDL LAG AMSKK X TSK STORA LSPRAT  
1 0 0 0.0 0.0 0.0 22. 0

SURFACE AREA= 0. 3. 14.  
CAPACITY= 0. 22. 216.  
ELEVATION= 1237. 1256. 1280.

CREL SPWID COQW EXPW ELEV COOL CAREA EXPL  
1255.3 64.0 2.6 1.5 0.0 0.0 0.0 0.0

DAM DATA  
TOPEL COOE EXPE DAMWID  
1257.1 3.1 1.5 86.

CREST LENGTH 20. 160. 140. 206. 400.  
AT OR BELOW  
ELEVATION 1257.1 1257.5 1258.0 1258.5 1260.0

PEAK OUTFLOW IS 4252. AT TIME 17.33 HOURS

PEAK OUTFLOW IS 3401. AT TIME 17.33 HOURS

PEAK OUTFLOW IS 2125. AT TIME 17.33 HOURS

PEAK OUTFLOW IS 1275. AT TIME 17.33 HOURS

PEAK OUTFLOW IS 849. AT TIME 17.33 HOURS

\*\*\*\*\*

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLows IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS				
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	0.80	0.50	0.30	0.20
HYDROGRAPH AT	1	1.95	1	4251.	3401.	2125.	1275.	850.
	(	5.05)	(	120.37)	96.29)	60.18)	36.11)	24.07)
ROUTED TO	2	1.95	1	4252.	3401.	2125.	1275.	849.
	(	5.05)	(	120.40)	96.31)	60.18)	36.10)	24.05)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....	ELEVATION	INITIAL VALUE		SPELLOWAY CREST		TOP OF DAM	
		STORAGE	OUTFLOW	STORAGE	OUTFLOW	STORAGE	OUTFLOW
		1256.00	22.	1255.30	20.	1257.10	26.
			99.		0.		407.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1259.79	2.69	38.	4252.	14.25	17.33	0.0
0.80	1259.45	2.35	36.	3401.	12.50	17.33	0.0
0.50	1258.80	1.70	33.	2125.	9.75	17.33	0.0
0.30	1258.20	1.10	31.	1275.	7.42	17.33	0.0
0.20	1257.79	0.69	29.	849.	5.08	17.33	0.0

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

```

1      A1      NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
2      A2      HYDROLOGIC AND HYDRAULIC ANALYSIS OF BAGGALEY DAM
3      A3      PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD
4      B      300      0      5      0      0      0      0      0      0      0
5      B1      5
6      J      2      1      1
7      J1     0.28
8      K      0      1
9      K1      INFLOW HYDROGRAPH FOR BAGGALEY DAM
10     M      1      1      1.95      1.95
11     P      24      102      120      130
12     T
13     W      1.73      0.45
14     X      -1.5     -0.05      2.0
15     K      1      2
16     K1      ROUTING AT BAGGALEY DAM
17     Y
18     Y1      1
19     $A      0.0      3.48      13.8
20     $E1236.8 1256.0 1280.0
21     $$1255.3 64.      2.63      1.5
22     $D1257.1 3.08      1.5      186.
23     $L      20.      160.      140.      206.      400.
24     $V1257.1 1257.5 1258. 1258.5 1260.
25     $B      150.      0.5      1237.1 2.0 1255.3 1260.
26     $B      150.      0.5      1237.1 2.0 1255.3 1258.1
27     K      1      3
28     K1      MOD PULS ROUTING FROM DAM TO STATION 3
29     Y
30     Y1      1
31     Y6      .07      .03      .07      1055. 1170. 5000. .037
32     Y7      0.0      1170. 300. 1060. 1000. 1060. 1000. 1055. 1008. 1055.
33     Y7      1008. 1060. 1640. 1100. 2000. 1170.
34     K      1      4
35     K1      MOD PULS ROUTING FROM STATION 3 TO STATION 4
36     Y
37     Y1      1
38     Y6      .07      .03      .07      1005. 1120. 5000. .01
39     Y7      0.0      1120. 300. 1020. 800. 1010. 800. 1005. 815. 1005.
40     Y7      815. 1010. 1000. 1020. 3000. 1120.
41     K      99
42     A
43     A
44     A
45     A
46     A
  
```

# PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

```

      RUNOFF HYDROGRAPH AT      1
      ROUTE HYDROGRAPH TO      2
      ROUTE HYDROGRAPH TO      3
      ROUTE HYDROGRAPH TO      4
      END OF NETWORK
  
```

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

RUN DATE: 16 MAY 80  
 RUN TIME: 7. 9. 1

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS  
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF BAGGALEY DAM  
 PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

```

      JOB SPECIFICATION
      NQ      NHR      NMIN      IDAY      IHR      IMIN      METRC      IPLT      IPRT      NSTAN
      300      0      5      0      0      0      0      0      0
      JOPER      NWT      LROPT      TRACE
      5      0      0      0
  
```

MULTI-PLAN ANALYSES TO BE PERFORMED  
NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= 0.28

\*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR BAGGALEY DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE LAUTO  
1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA  
INHYD IUHG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL  
1 1 1.95 0.0 1.95 0.0 0.0 0 1 0

PRECIP DATA  
SPFE PMS R6 R12 R24 R48 R72 R96  
0.0 24.00 102.00 120.00 130.00 0.0 0.0 0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.300

LOSS DATA  
LROPT STRKR DLTGR RTIOL ERAIN STRKS RTIOK STRIL CNSTL ALSMX RTIMP  
0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA  
TP= 1.73 CP=0.45 NTA= 0

RECESSION DATA  
STRIO= -1.50 QRCN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 1.74 HOURS, CP= 0.45 VOL= 0.93  
3. 12. 25. 41. 60. 79. 101. 123. 147. 172.  
197. 222. 245. 266. 285. 301. 314. 325. 334. 339.  
340. 336. 327. 317. 307. 298. 289. 280. 272. 264.  
256. 248. 240. 233. 226. 219. 213. 206. 200. 194.  
188. 183. 177. 172. 166. 161. 157. 152. 147. 143.  
139. 134. 130. 126. 123. 119. 115. 112. 108. 105.  
102. 99. 96. 93. 90. 87. 85. 82. 80. 77.  
75. 73. 71. 68. 66. 64. 62. 61. 59. 57.  
55. 54. 52. 50. 49. 47. 46. 45. 43. 42.  
41. 39. 38. 37. 36. 35. 34. 33. 32. 31.

END-OF-PERIOD FLOW  
MO. DA HR. MN PERIOD RAIN EXCS LOSS COMP Q MO. DA HR. MN PERIOD RAIN EXCS LOSS COMP Q  
SUM 24.96 23.08 1.88 3206.9.  
( 634. ) ( 586. ) ( 48. ) 9078.93

\*\*\*\*\*

HYDROGRAPH ROUTING

ROUTING AT BAGGALEY DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE LAUTO  
2 1 0 0 0 0 1 0 0

ALL PLANS HAVE SAME  
ROUTING DATA

CLOSS CLOSS AVG IRES ISAME IOPT IPMP LSTR  
0.0 0.0 0.0 1 1 0 0 0

NSTPS NSTDL LAG AMSKK X TSK STORA ISPRAT  
1 0 0 0.0 0.0 0.0 22. 0

SURFACE AREA= 0. 3. 14.  
CAPACITY= 0. 22. 216.  
ELEVATION= 1237. 1256. 1280.

CREL SPWID COOW EXPW ELEV COGL CAREA EXPL  
1255.3 64.0 3.6 1.5 0.0 0.0 0.0 0.0

				TOPEL	DAM DATA		
				1257.1	COOD	EXPD	DAMWID
					3.1	1.5	186.
CREST LENGTH	20.	160.	140.	206.	400.		
AT OR BELOW							
ELEVATION	1257.1	1257.5	1258.0	1258.5	1260.0		

		DAM BREACH DATA			
BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
150.	0.50	1237.10	2.00	1255.30	1260.00

PEAK OUTFLOW IS 1190. AT TIME 17.33 HOURS

		DAM BREACH DATA			
BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
150.	0.50	1237.10	2.00	1255.30	1258.10

BEGIN DAM FAILURE AT 17.08 HOURS

PEAK OUTFLOW IS 1553. AT TIME 17.54 HOURS

\*\*\*\*\*

#### HYDROGRAPH ROUTING

MOD PULS ROUTING FROM DAM TO STATION 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	LAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKX	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

#### NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0700	0.0300	0.0700	1055.0	1170.0	5000.	0.03700

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.0	1170.00	300.00	1060.00	1000.00	1060.00	1000.00	1055.00	1008.00	1055.00
1006.00	1060.00	1640.00	1100.00	2000.00	1170.00				

STORAGE									
0.0	91.30	635.67	1257.94	1958.12	2736.20	3592.19	4526.07	5530.71	6572.69
7647.75	8755.91	7897.16	11071.50	12278.94	13519.45	14793.08	16099.79	17439.59	18812.49

OUTFLOW									
0.0	4040.81	32162.69	236809.75	461798.00	756799.87	1123160.00	1562958.00	2092631.00	2707016.00
3393039.00	4149612.00	4976081.00	5872106.00	6837587.00	7872592.00	8977338.00	10152143.0	11397402.0	12713586.0

STAGE									
1055.00	1061.05	1067.10	1073.16	1079.21	1085.26	1091.31	1097.37	1103.42	1109.47
1115.52	1121.58	1127.63	1133.68	1139.73	1145.79	1151.84	1157.89	1163.94	1170.00

FLOW									
0.0	4040.81	32162.69	236809.75	461798.00	756799.87	1123160.00	1562958.00	2092631.00	2707016.00
3393039.00	4149612.00	4976081.00	5872106.00	6837587.00	7872592.00	8977338.00	10152143.0	11397402.0	12713586.0

MAXIMUM STAGE IS 1056.7

MAXIMUM STAGE IS 1057.2

\*\*\*\*\*

## HYDROGRAPH ROUTING

MOD PULS ROUTING FROM STATION 3 TO STATION 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	LAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME  
ROUTING DATA

GLOSS	GLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTD	LAG	AMSK	X	TSK	STOR	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

## NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0700	0.0300	0.0700	1005.0	1120.0	5000.	0.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.0	1120.00	300.00	1020.00	800.00	1010.00	800.00	1005.00	815.00	1005.00
815.00	1010.00	1000.00	1020.00	3000.00	1120.00				

STORAGE										
0.0	14.78	219.30	685.82	1270.94	1952.77	2731.31	3606.57	4578.53	5647.21	
6812.59	8074.69	9433.50	10889.02	12441.26	14090.21	15835.86	17678.23	19617.30	21653.10	

OUTFLOW										
0.0	1117.94	11947.42	53472.32	131707.50	244288.00	392689.56	578822.19	804764.75	1072661.00	
1384680.00	1742984.00	2149722.00	2607026.00	3116999.00	3681717.00	4303239.00	4983594.00	5724777.00	6528763.00	

STAGE										
1005.00	1011.05	1017.10	1023.16	1029.21	1035.26	1041.31	1047.37	1053.42	1059.47	
1065.52	1071.58	1077.63	1083.68	1089.73	1095.79	1101.84	1107.89	1113.94	1120.00	

FLOW										
0.0	1117.94	11947.42	53472.32	131707.50	244288.00	392689.56	578822.19	804764.75	1072661.00	
1384680.00	1742984.00	2149722.00	2607026.00	3116999.00	3681717.00	4303239.00	4983594.00	5724777.00	6528763.00	

MAXIMUM STAGE IS 1011.1

MAXIMUM STAGE IS 1011.2

\*\*\*\*\*

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLows IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO	RATIOS APPLIED TO FLOWS
				0.28	
HYDROGRAPH AT	1	1.95	1	1190.	
	(	5.05)	(	33.70)	
			2	1190.	
			(	33.70)	
ROUTED TO	2	1.95	1	1190.	
	(	5.05)	(	33.69)	
			2	1550.	
			(	43.88)	
ROUTED TO	3	1.95	1	1167.	
	(	5.05)	(	33.05)	
			2	1460.	
			(	41.59)	

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 2	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	1255.30	1255.30	1257.10	
STORAGE	20.	20.	26.	
OUTFLOW	0.	0.	407.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.28	1258.10	1.00	30.	1553.	2.75	17.54	17.08

PLAN 2		STATION 3	
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.28	1469.	1057.2	17.75

PLAN	STATION	4	
RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.28	1158.	1011.1	17.92

PLAN	2	STATION	4
RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.28	1427.	1011.2	18.00

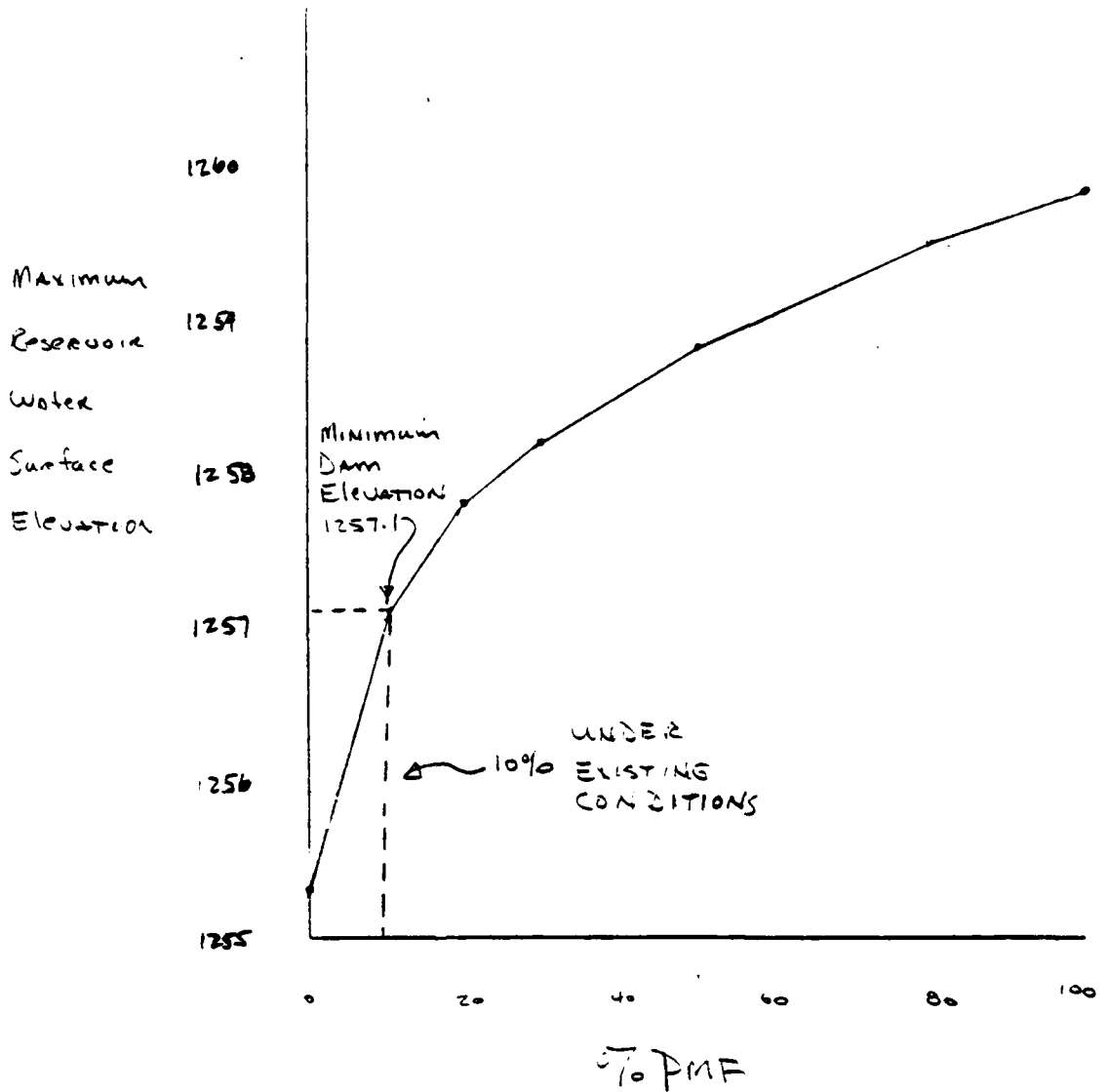




ACKENHEIL & ASSOCIATES  
GEO Systems, Inc.  
1000 Banksville Road  
PITTSBURGH, PA. 15216  
(412) 531-7111

Sheet \_\_\_\_\_ of \_\_\_\_\_

Job Bagsley Dam Job No. 791530  
Subject SPILLWAY / RESERVOIR ELEVATION CURVE  
Made By JDH Date 4/29/90 Checked ELB Date 4/24/92

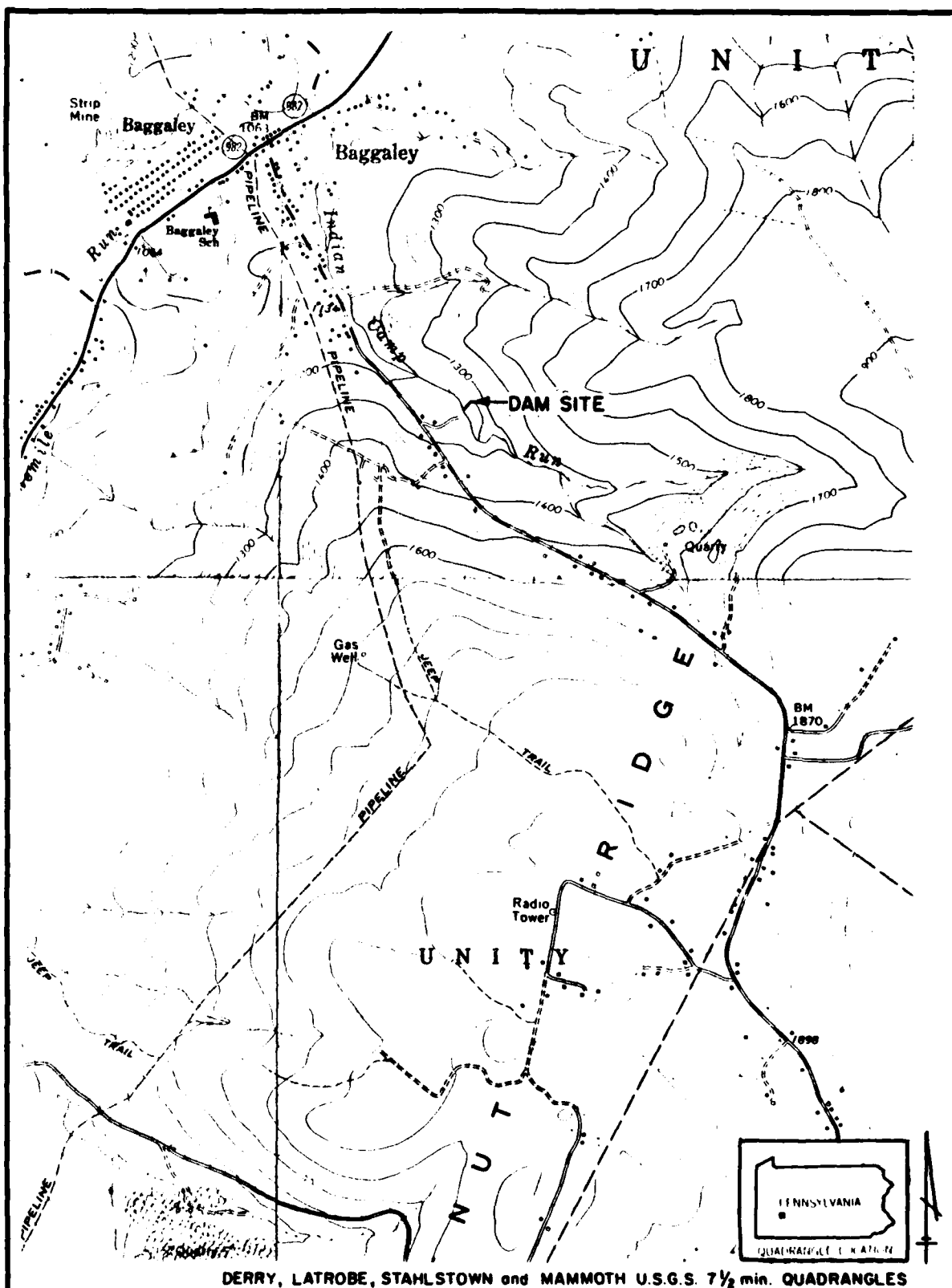


APPENDIX E

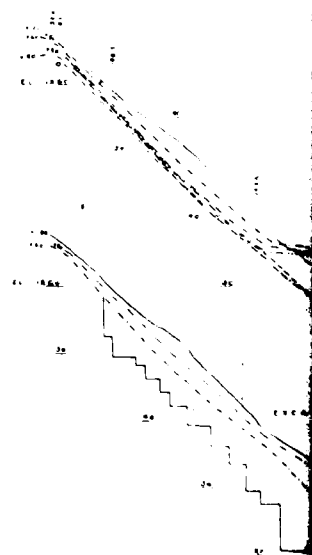
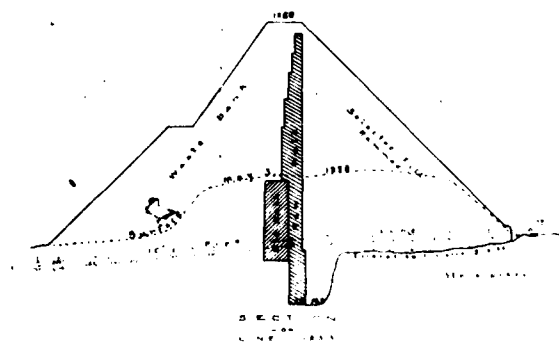
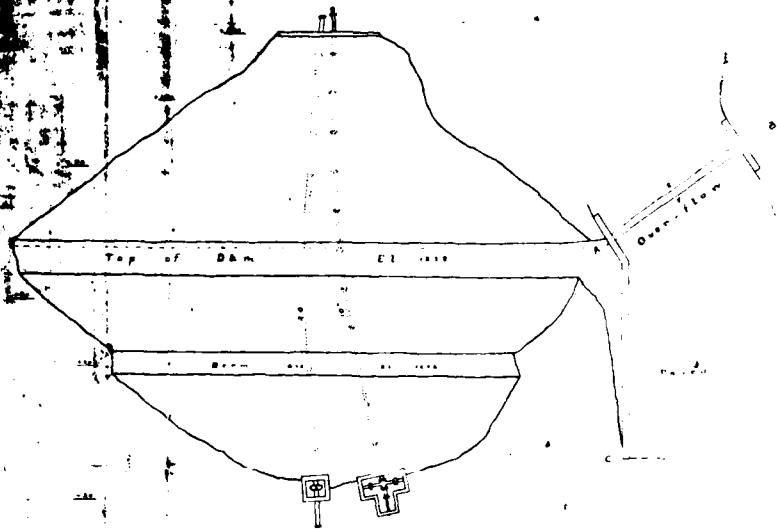
PLATES

### LIST OF PLATES

- |           |   |
|-----------|---|
| Plate I   | Regional Vicinity Map.  |
| Plate II  | Puritan Water Company - Showing plan, core-wall elevation, embankment section and surface profiles. |
| Plate III | Map showing property of Puritan Water Company, Reservoir, Source of Supply and Distribution System. |
| Plate IV  | Gate House and Walkway, Details of Stream Railroad Crossings and Fire Hydrant.                      |



DATE: MAY 1980		BAGGALEY DAM NATIONAL DAM INSPECTION PROGRAM		REGIONAL VICINITY MAP
SCALE: 1" = 2000'				
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.		
DWG. NO. PLATE I				

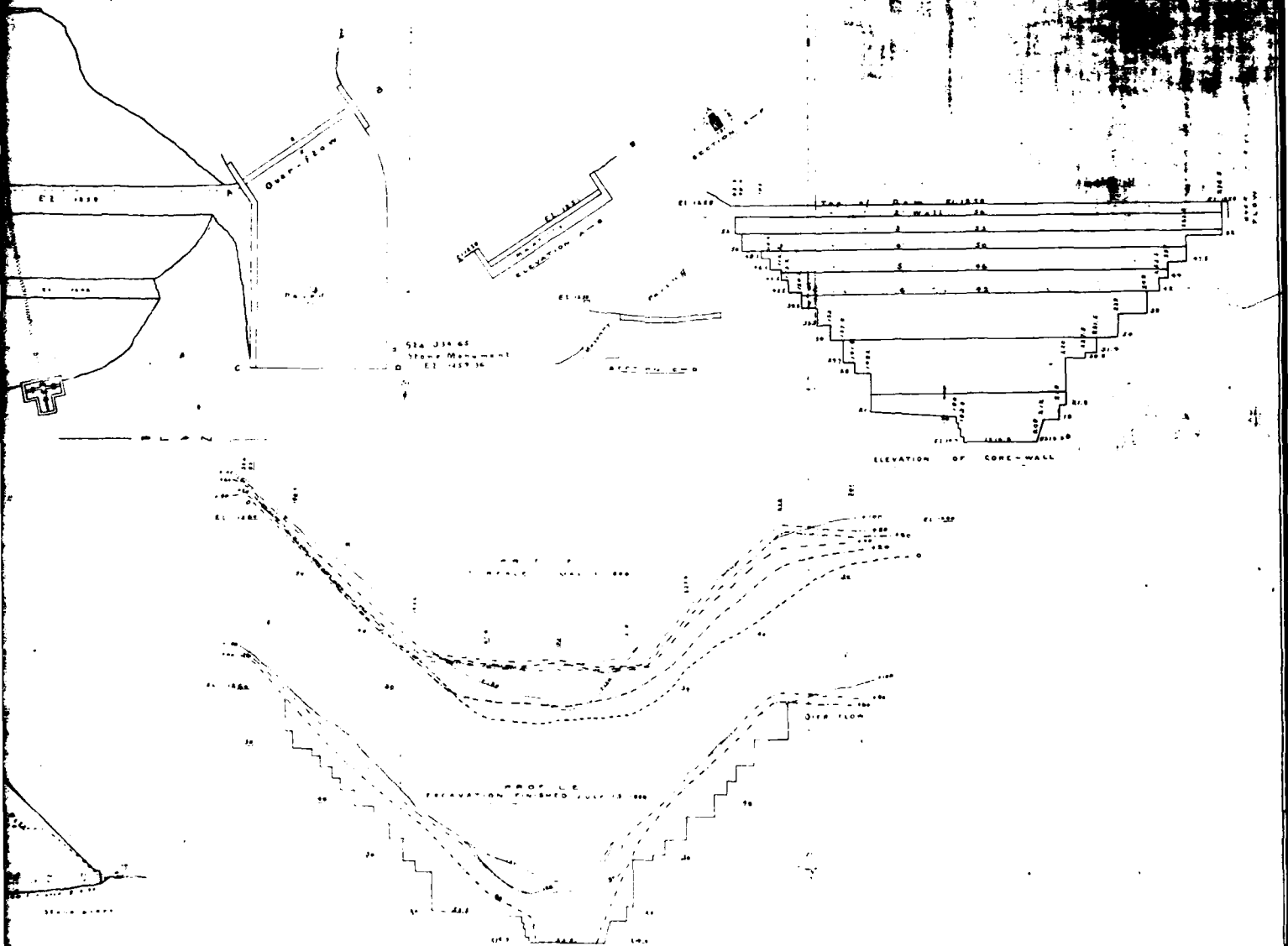


# PURITAN WATER COMPANY. WOLF SPRING RESERVOIR DAM

1899

Hor. Scale 1 inch = 20 feet  
Ver. Scale 1 inch = 10 feet  
Origin Datum

James H. Harlow & Co. Engs.



DRAINAGE AREA 1250 ACRES

NOTES -

CONTRACTOR TO LAY 6" TEMPORARY WATER LINE FROM UPPER END OF RESERVOIR TO EXISTING 10" OUTLET LINE TO SUPPLY BAGGALEY

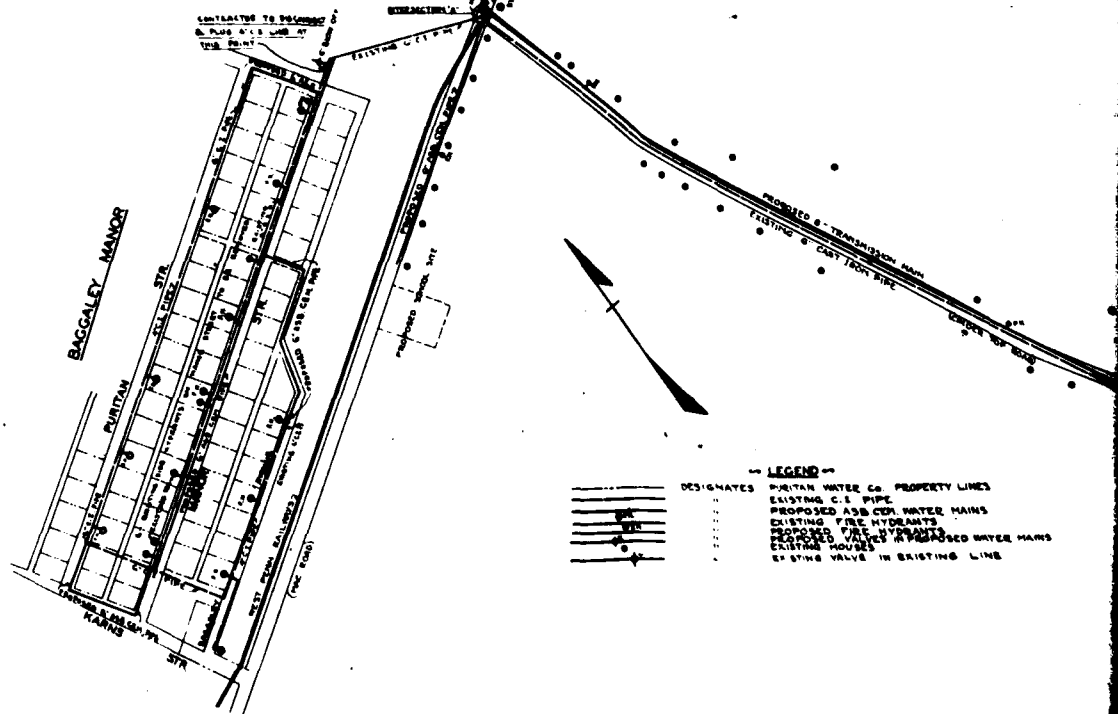
CONTRACTOR TO DISCONNECT EXISTING 4" CI WATER LINE ON MANDE STREET IN BAGGALEY MANOR

CONTRACTOR TO DISCONNECT SERVICE LINES FROM EXISTING 4" CI WATER LINE AND CONNECT TO PROPOSED 6" ASBESTOS CEMENT WATER DISTRIBUTION MAIN ON MANDE STREET IN BAGGALEY MANOR

CONTRACTOR TO REMOVE 6" & 8" EXISTING FIRE HYDRANTS ON MANDE STREET AS SHOWN ON PLAN

12" & 14" 8" ASBESTOS CEMENT PIPE TO BE INSTALLED BETWEEN INTERSECTION 'A' & BAGGALEY & INTERSECTION 'B' FOR LOCATION OF INTERSECTION 'B' SEE SHEET NO. 400 SHEET 1 OF 1

CONTRACTOR TO DISCONNECT 6" & 8" CI WATER LINE AT THE POINT

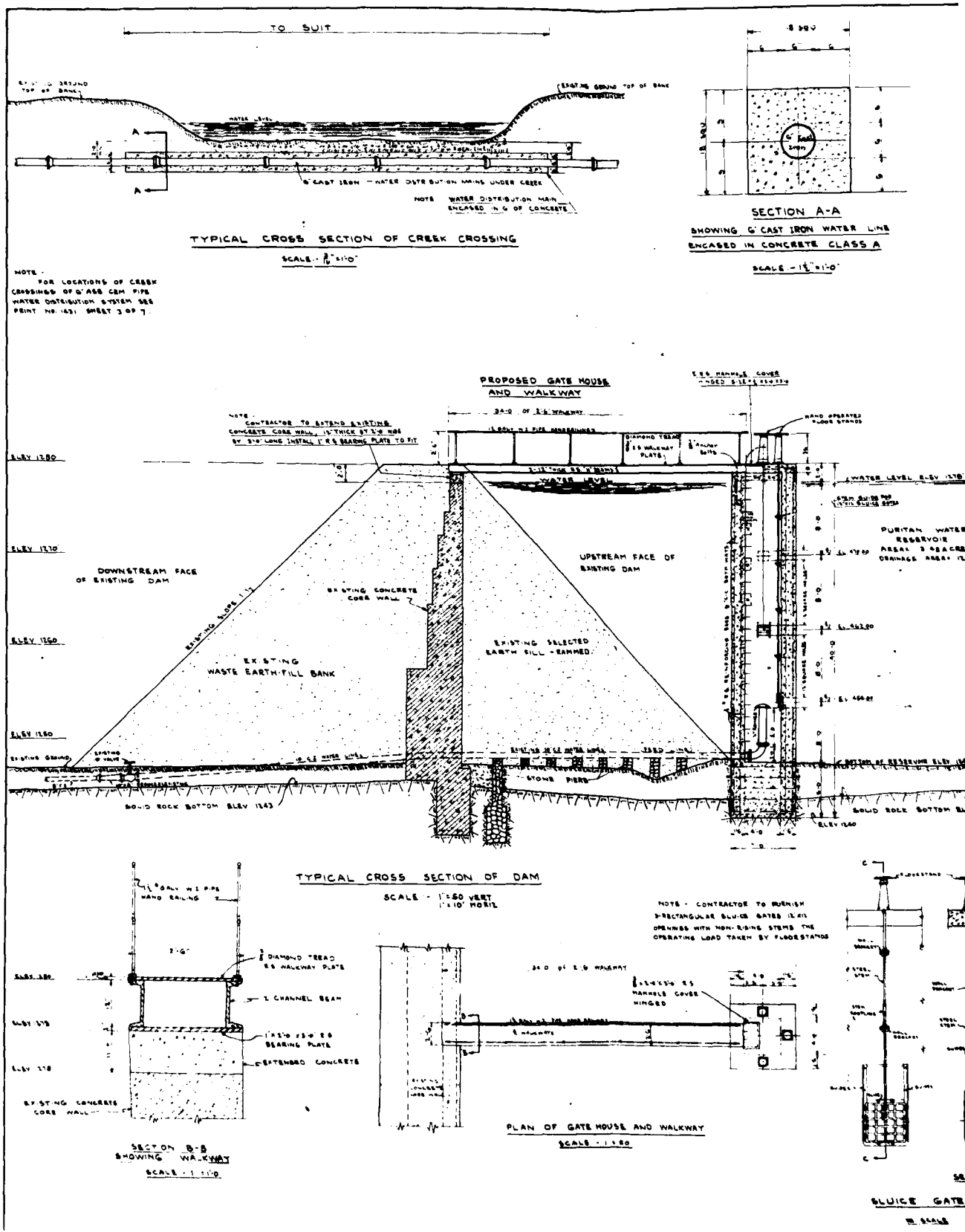


LEGEND

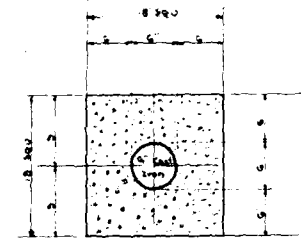
DESIGNATES	DESCRIPTION
---	PURITAN WATER CO. PROPERTY LINES
---	EXISTING C.I. PIPE
---	PROPOSED 6" ASBESTOS CEMENT MAINS
---	EXISTING FIRE HYDRANTS
---	PROPOSED 6" & 8" ASBESTOS CEMENT MAINS
---	EXISTING HOUSES
---	EXISTING VALVE IN EXISTING LINE



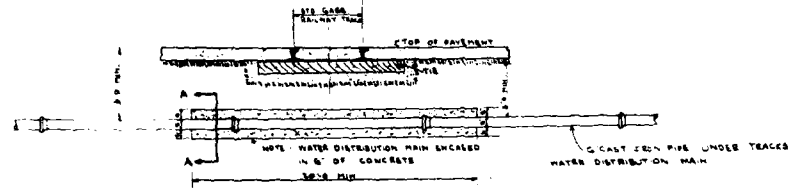




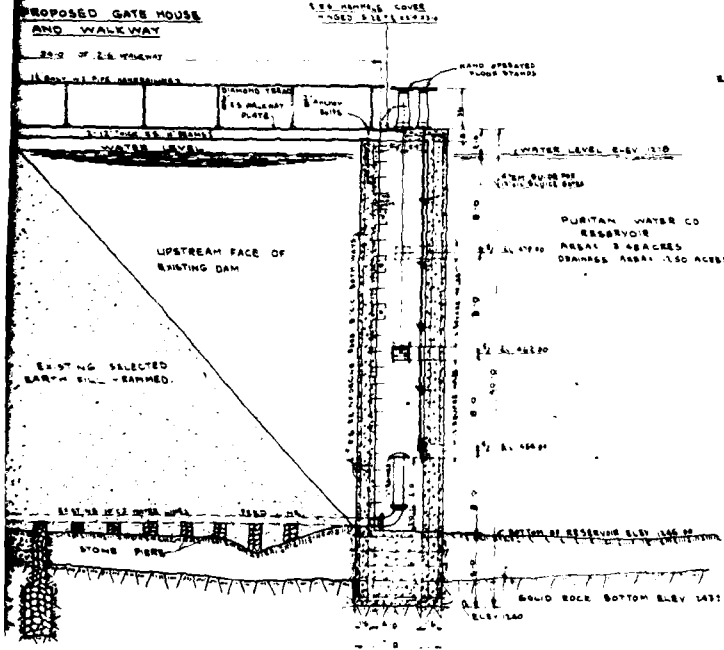
NOTE:  
FOR LOCATIONS OF TRAIL  
CROSSINGS SEE PLAN SHEET 3 OF 7



SECTION A-A  
SHOWING 5' CAST IRON WATER LINE  
ENCASED IN CONCRETE CLASS A  
SCALE - 1/2" = 1'-0"



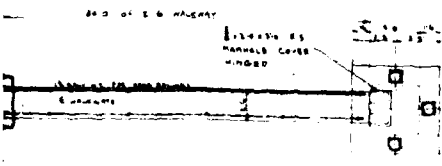
TYPICAL CROSS SECTION OF RAILWAY CROSSING  
SCALE - 1/2" = 1'-0"



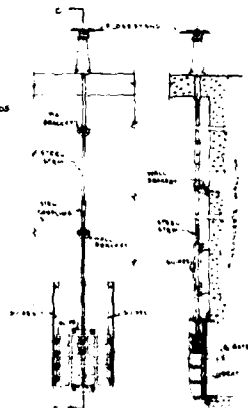
PLAN OF DAM

NOTES:

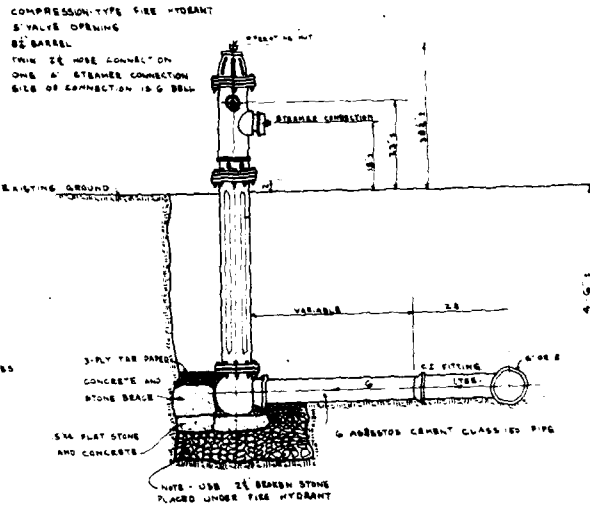
NOTE: CONTRACTOR TO PURCHSE  
RECTANGULAR SLUICE GATES 12' x 12'  
DRIVEN WITH HIGH STANG STEEL THE  
OPERATING LOAD TAKEN BY FLOOD STANDS



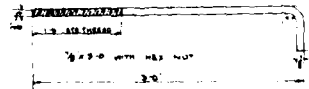
PLAN OF GATE HOUSE AND WALKWAY  
SCALE - 1/2" = 1'-0"



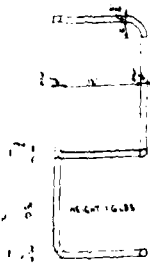
SLUICE GATE DETAIL  
SCALE - 1/2" = 1'-0"



TYPICAL SECTION OF FIRE HYDRANT  
SCALE - 1/2" = 1'-0"



DETAIL OF ANCHOR BOLT  
SCALE - 1/2" = 1'-0"  
REQUIRED = 2



DETAIL OF W X MANHOLE STEP  
SCALE - 1/2" = 1'-0"  
REQUIRED = 2

DATE	DESCRIPTION
1934	REVISIONS
1934	PLAN, SECTIONS AND ELEVATIONS
1934	BOROUGH OF YOUNGSTOWN
1934	YOUNGSTOWN, PENNA.
1934	GATE HOUSE AND WALKWAY
1934	DETAILS OF STREAM, RAILWAY CROSSINGS
1934	AND FIRE HYDRANT
1934	RICHARD J. HARMAN CONSULTING ENGINEER
1934	212 NORTH THIRD STREET - HARRISBURG, PENNA.
1934	PENNA. STATE CHAMBER OF COMMERCE BUILDING
1934	DESIGNED BY: H. E. HARRIS
1934	DRAWN BY: H. E. HARRIS
1934	CHECKED BY: H. E. HARRIS
1934	APPROVED: H. E. HARRIS

DWG NO. 1434

AD-A087 758

ACKENHEIL AND ASSOCIATES INC PITTSBURGH PA  
NATIONAL DAM INSPECTION PROGRAM, BAGGALEY DAM, (NDI NUMBER PA-0--ETC(U)  
MAY 80 J P HANNAN, J E BARRICK

F/G 13/13

DACW31-80-C-0026

NL

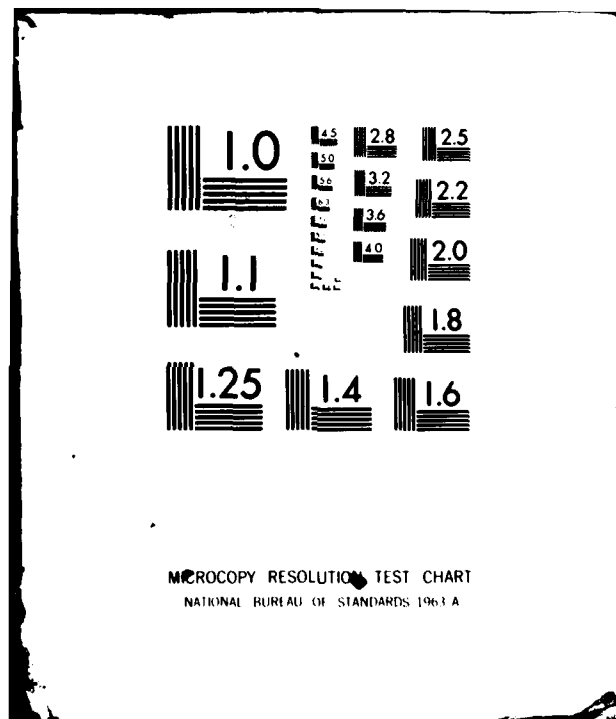
UNCLASSIFIED

2 - 2

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END  
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APPENDIX F

GEOLOGY

## GEOLOGY

### Geomorphology

Physiographic Province: Baggaley Dam is located on Indian Camp Run on the west flank of Chestnut Ridge. The rocks which underlie the site are part of the Allegheny Mountain section of the Appalachian Plateau physiographic province. The Allegheny Mountain section is characterized by elongated anticlinal ridges trending about N30°E, that have a local relief of as much as 1,500 ft.

Local Feature: Indian Camp Run, a tributary of Ninemile Run, cuts a steep sided valley into the rocks of Chestnut Ridge. The valley walls surrounding Baggaley dam are strewn with large massive blocks of sandstone. These blocks are believed to have slid down the hillside after the underlying supportive shale beds had been weathered away.

### Structure

General: Baggaley Dam lies approximately 1 mile southwest of the axis of the Chestnut Ridge anticline. The Mauch Chunk formation, which outcrops in the immediate vicinity of the dam, dips about 20° to the northwest.

Faults: No observations were made that would indicate faulting in the rocks outcropping around the dam site. In general, only a few evidences of faulting have been observed in all of Westmoreland County.

### Stratigraphy

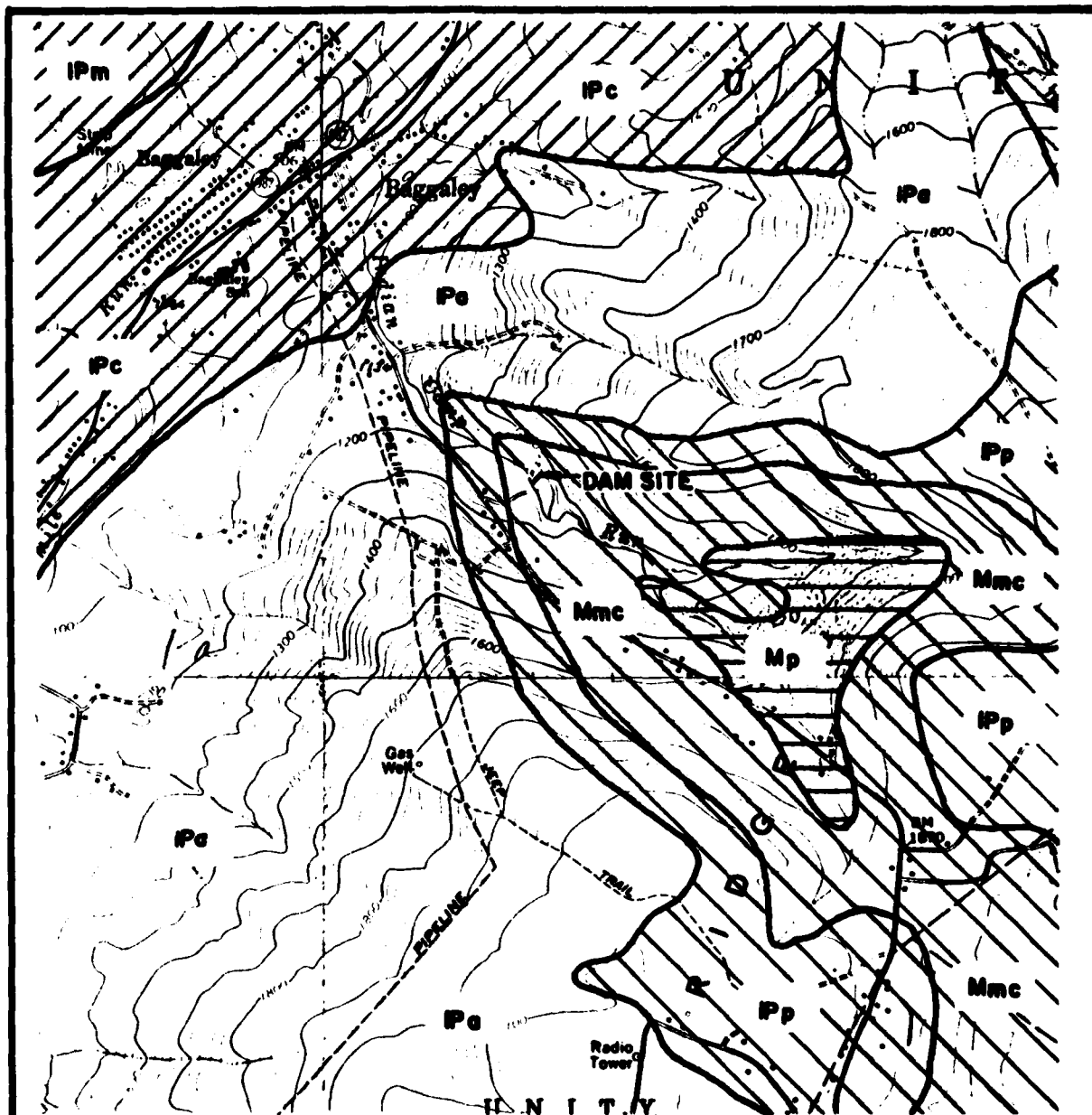
General: Rocks in the vicinity of Baggaley Dam are part of the Mauch Chunk Formation of Mississippian age.

Mauch Chunk: The Mauch Chunk has been described as containing three members:

1. A lower red and green shale and micaceous sandstone;
2. A dark blue-black fossiliferous massive limestone and interbedded gray shale;
3. An upper bright red shale with some green shale and micaceous or arkosic sandstone.

The dam site is underlain by the upper portion of the Mauch Chunk.

The thickness of the upper member is believed to range from 100 to 175 ft.



**DERRY, LATROBE, STAHLSTOWN AND MAMMOTH QUADRANGLES  
WESTMORELAND COUNTY, PENNSYLVANIA**

SCALE: 0 1/2 MILE 1:24000

CONTOUR INTERVAL 20 FT. DATUM IS MEAN SEA LEVEL  
—— FORMATION CONTACT

DATA OBTAINED FROM PENNSYLVANIA TOPOGRAPHIC AND GEOLOGIC SURVEY GREATER PITTSBURGH REGION GEOLOGIC MAP AND CROSS SECTIONS, 1973 and GREATER PITTSBURGH REGION STRUCTURE CONTOUR MAP, 1973

DATE: MAY 1980	BAGGALEY DAM NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC MAP
SCALE: 1" = 2000'		
DR:      CK:	<b>A. C. ACKENHEIL &amp; ASSOCIATES, INC.</b> CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	



AGE	THICKNESS	THICKNESS	COLUMNAR SECTION	PROMINENT BEDS
QUATERNARY				PLEISTOCENE GLACIAL OUTWASH, RIVER TERRACE DEPOSITS AND ALLUVIUM
PERMIAN	BARKLAND (Pp-6)	WYNESSBURG (Pp-12)		UPPER WASHINGTON LIMESTONE
				WASHINGTON COAL
				WYNESSBURG SANDSTONE
				WYNESSBURG COAL
PENNSYLVANIAN	MONONGAHELA (Pp-14)	PITTSBURGH (Pp-14)		UNIONTOWN SANDSTONE
				UNIONTOWN COAL
				BENWOOD LIMESTONE
				SEWICKLEY COAL
	COKEAUGH (Pp-14)	CAMELPAUGH (Pp-14)		PITTSBURGH SANDSTONE
				PITTSBURGH COAL
				CONNELLSVILLE SANDSTONE
				MORGANTOWN SANDSTONE
	GLENDALE (Pp-14)			AMES LIMESTONE
				PITTSBURGH RED BEDS
				SALTSBURG SANDSTONE
				MAHONING SANDSTONE
	ALLEGHENY (Pp-14)			UPPER FREEPORT COAL
				UPPER KITTANNING COAL
				WORTHINGTON SANDSTONE
				LOWER KITTANNING COAL
MISSISSIPPIAN	POTOMAC (Pp-14)			HOMEROCK SANDSTONE
				MERCER SANDSTONE, SHALE & COAL
				CONOQUEWESING SANDSTONE
MISSISSIPPIAN	POCONO (Pp-14)			BURDOON SANDSTONE
				CUYAHOGA SHALE
				BEREA SANDSTONE

DATE: MAY 1980

SCALE: NONE

DR: JF

CK: JPH

BAGGALEY DAM  
NATIONAL DAM INSPECTION PROGRAM

A. C. ACKENHEIL & ASSOCIATES, INC.  
CONSULTING ENGINEERS  
PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.

GEOLOGIC  
COLUMN

